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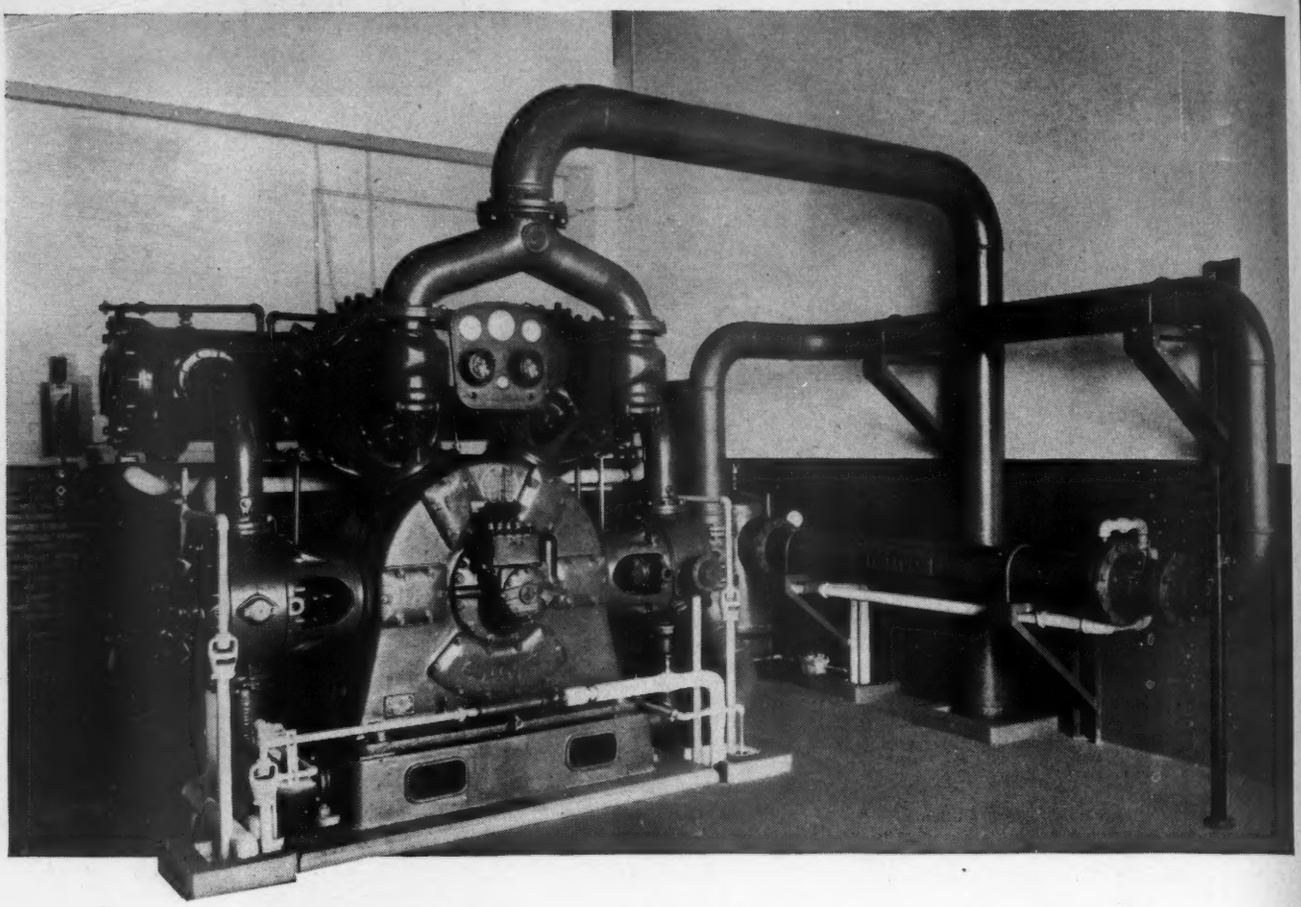
STEEL SKELETON OF HUGE SIPHON

Framework for supporting concrete walls of water conduit in Washington

(Bureau of Reclamation Photo)

VOLUME 52 • NUMBER 9 NEW YORK • LONDON



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VOLUME 52 **September, 1947** NUMBER 9

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EDITORIAL CONTENTS

Under the Bay to Brooklyn—*R. G. Skerrett* 210
Princeton University's Unique New Library—*C. H. Vivian* 217
Keys to Everything—*Allen S. Park* 223
Compressed Air at Work 226
Editorials—Brooklyn-Battery Tunnel—Birthday of U. S. Irrigation .. 228
This and That 229
Machine Removes Scale from Welded Axle Housings 230
New Army Air Dreadnought 230
Sound Waves Inspect Metal 230
New Books 231
New Process Forecasts Wider Use of Titanium 232
Industrial Notes 233

ADVERTISING INDEX

Air-Maze Corp. 36
Allis-Chalmers Co. 28
American Leather Belting Assn. 16
Bethlehem Steel Co. 10, 30
Black, Sivalls & Bryson, Inc. 37
Bucyrus Erie Co. 14
Burke Electric Co. 17
Combustion Engineering Co. 23
Compressed Air Magazine 40
Conrader Co., R. 38
Cook Mfg. Co., C. Lee 27
Crane Co. 8
Cuno Engineering Corp. 22
Dollinger Corp. 3
Easton Car & Construction Co. 11
Eimco Corp., The 9
Electric Machinery Mfg. Co. 13
Fairbanks Co., The 41
Galland-Henning Mfg. Co. 39
General Electric Co. 31, 32
Industrial Clutch Corp. 35
Ingersoll-Rand Co. 4, 15, 24, 33
Leavitt Machine Co., The 40
Maxim Silencer Co., The 36
National Forge & Ordnance Co. 21
Naylor Pipe Co. 19
New Jersey Meter Co. 39
Nicholson & Co., W.H. 37
Norgren Co., C.A. 38
Norton Co. 18
Rhoads & Sons., J. E. ..... 3rd Cover
Roebling's Sons Co., John A. 5
Schieren Co., Chas. A. 38
Socony-Vacuum Oil Co., Inc. ..... 4th Cover
Square D Co. 37
Terry Steam Turbine Co., The 29
Texas Co., The ..... 2nd Cover
Timken Roller Bearing Co., The .. 12
Victaulic Co. of America 20
Vogt Machine Co., Inc., Henry ... 34
Wagner Electric Corp. 26
Walworth Co. 25
Wisconsin Motor Corp. 36
Westinghouse Electric Corp 6, 7

A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

CCA Member Controlled Circulation Audit

Published by Compressed Air Magazine Co., G. W. MORRISON, *President*; C. H. VIVIAN, *Vice-President*; J. W. YOUNG, *Secretary-Treasurer*.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York 4, N. Y., L. H. GEYER, *Representative*.
Annual subscription: U.S., $3.00; foreign, $3.50. Single copies, 35 cents. COMPRESSED AIR MAGAZINE is on file in many libraries and is indexed in Industrial Arts Index.

ON THE COVER

TO DISTRIBUTE water stored behind Grand Coulee Dam to arid land in the Big Bend section of Washington State, it will be necessary at one place to cross a dry coulee. This link in the conduit will take the form of a 4400-foot siphon. It is now being built for the U. S. Bureau of Reclamation by the Utah Construction Company of San Francisco and Winston Brothers of Los Angeles Calif., as a part of a $2,871,796 contract for the first 6½ miles of the 88-mile West Canal. The latter will carry water to 281,000 acres in the western part of the million-acre Columbia Basin Project. Our cover picture shows multiple steel hoops 84 feet in circumference that will serve as ribs for the 2-foot concrete shell of the siphon. In the background are forms for pouring concrete. Viewing the work is a project visitor, Col. G.Y.L. Crossley, field representative of the Bureau of Reconstruction, Government of British Columbia.

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IN THIS ISSUE

AS THE years pass, New Yorkers spend more and more of their time underneath the earth's surface. If you are on foot in Gotham and want to go anywhere in a hurry you ride the subway, which hurtles you along at around 40 miles per hour, oblivious of traffic congestion in the streets overhead. There was a time when motorists bound to or from insular Manhatten, key borough of the city, used bridges or ferries. Now there are two subaqueous tunnels connecting with the New Jersey shore and one with the Borough of Queens. A fourth twin-tube thoroughfare, which will be larger than any of these, is now being driven under the bay to Brooklyn. Our leading article is the first of two describing its construction. The second part will appear in October.

•

BUILDING a library such as the one that is now taking form at Princeton University can be almost a lifework. A good many persons have spent an appreciable amount of their time for the past twenty years laying the groundwork for the 6-million-dollar structure. It embodies many innovations and will, perhaps, set a pattern for future libraries on college or university campuses. See page 217.

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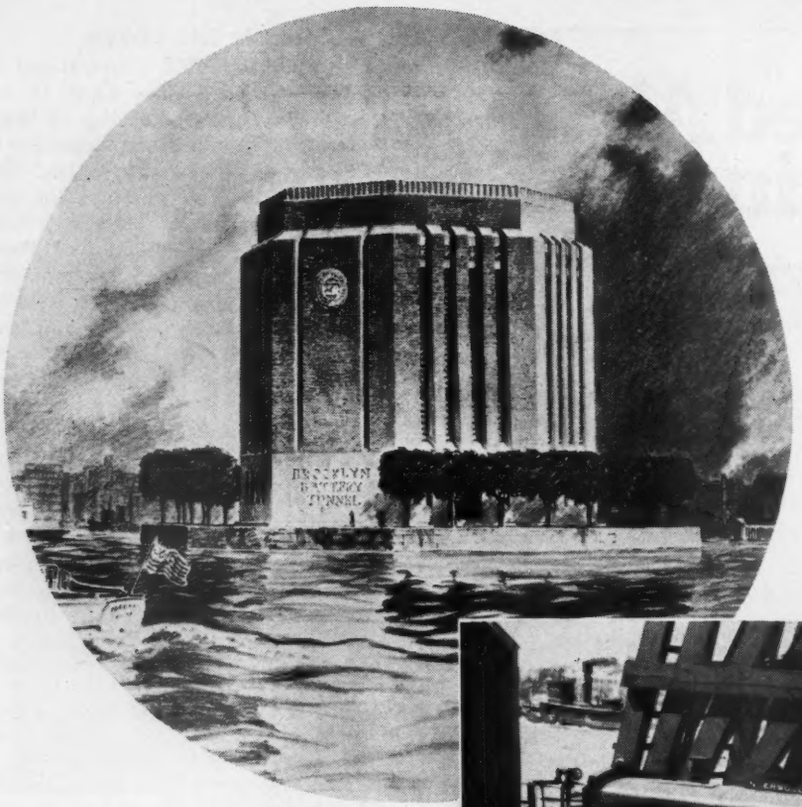
IF YOU'VE lost a door or car key, perhaps the finder has sent it to Baldpate Inn, a mountain hotel in Colorado. At any rate, we'll wager you could find a duplicate there among the 10,000 and more that constitute the largest collection of keys outside of a key factory. See page 223.

Under the Bay to Brooklyn

R. G. Skerrett

ILLUSTRATIONS FROM TRIBOROUGH BRIDGE & TUNNEL AUTHORITY



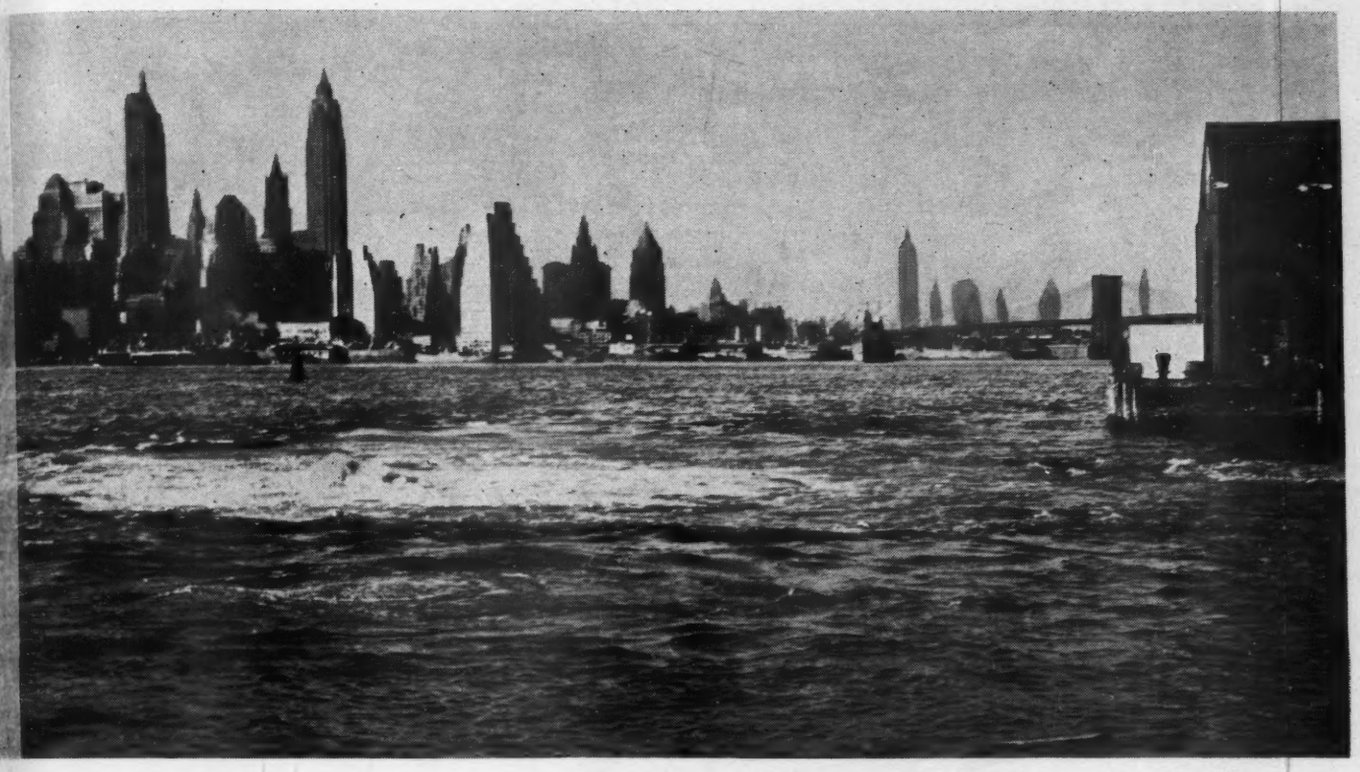
MISCELLANEOUS VIEWS

The white patch on the water's surface in the picture at the right is compressed air escaping from the heading of one of the tubes being driven northward from Brooklyn toward Manhattan, whose skyscrapers are in the background. Visible at the upper right is a part of Brooklyn Bridge—the first vehicular travelway between the two boroughs that are now being connected by another underwater artery. In the circle is an artist's drawing of the ventilation building that will stand about midlength of the two tunnels. It will occupy a man-made island just offshore from Governors Island. In driving the headings from Brooklyn, it has been necessary in places to lay a blanket of clay on the bay bottom to increase the cover over the compressed-air shields to a safe thickness. When no longer needed, the clay was removed. This was usually done by dredging, but along one stretch this procedure would have disturbed or broken water lines and electric conduits running to Governors Island. Consequently, the clay was first broken up with jets of compressed air and then pumped into barges by means of air lifts. The view just above shows this work in progress, with a portable compressor that supplied the necessary air.

NEW YORK CITY'S fourth and longest twin-tube, subaqueous vehicular highway is nearing its most momentous construction stage—the "holing through" of the oppositely advancing headings at a point in midstream more than 100 feet below the surface of the swift East River. But for World War II, the tunnel and its terminal features would have been finished and opened to traffic in the fall of 1944; and thousands of drivers of automotive vehicles between the southern tip of Manhattan and the neighboring shore of Brooklyn would be enjoying the benefits of another engineering triumph. As it is, sustained efforts will be needed to complete the project some time in 1949.

Next year will mark the semicentennial of the consolidation of the separate areas that form the City of Greater New York—the five boroughs of Manhattan, Brooklyn, The Bronx, Queens, and Richmond. That union was first urged in 1868 by Andrew H. Green, a public-spirited citizen of Brooklyn, but did not become a reality until 30 years later. With that amalgamation, New York's growing pains began in earnest, only to become recurrent with varying intensity. Such was the natural outcome of an abruptly and vastly enlarged body politic and its readjustment as a single community with reciprocal interests and interrelated material needs. A civic celebration will commemorate the Golden Jubilee, and then the populace will perhaps become fully aware of some of the reasons for the successive construction of the Holland, the Lincoln, the Queens-Midtown, and the Brooklyn-Battery tunnels—all consequences of the city's continual growth and need for more and still more rapid-transit facilities.

In 1900, two years after the consolidation, Greater New York had a population of 3,437,202, as follows: Manhattan, 1,850,093; Brooklyn, 1,166,582; The Bronx, 200,507; Queens, 152,999; and Richmond 67,021. Today, there are an estimated 7,835,000 persons in the boroughs, and the way they are distributed gives a hint of one major cause for the continually mounting transportation and traffic problems. Brooklyn now has



2,798,000 inhabitants—892,000 more than Manhattan, which is a long and relatively narrow island and the smallest of all the boroughs. The Bronx and Queens are close competitors, having 1,489,000 and 1,456,000 residents, respectively, and each aspires to outstrip Manhattan in numbers. Even so, the latter maintains her financial and business dominance, which is historic.

Every working day the island is the goal for an immense influx of people not only from the neighboring boroughs but from outlying counties in New York State and from Connecticut and New Jersey. The majority of these migrants surcharge the rapid-transit facilities every week-day morning and late afternoon, but the greatest present difficulty is to provide more and ampler ways to accommodate the automotive vehicles entering and leaving Manhattan and threading its thoroughfares so that they can travel faster and with less frequency of congestion.

In the interval between 1924 and 1942, before the war crimped motor-car production, the registered vehicles in Greater New York increased from just short of 430,000 to more than one million. No wonder Manhattan's few main traffic arteries are suffering from high pressure. The Brooklyn-Battery Tunnel, which will handle an estimated 16,000,000 vehicles annually, should prove of great aid in ameliorating the rush-hour flow over the three lower bridges that link the island and Brooklyn.

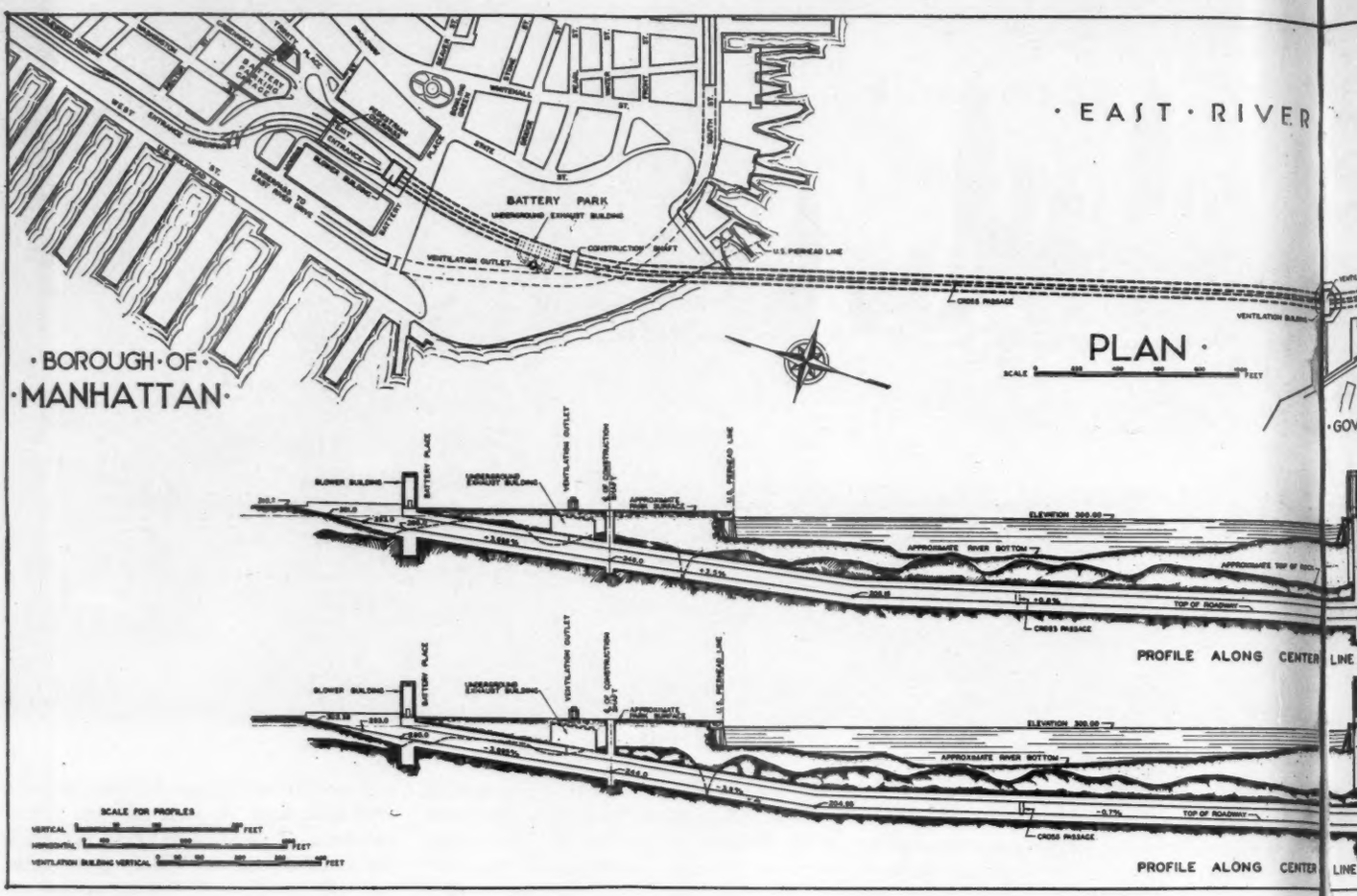
Preliminary plans for the Brooklyn-Battery Tunnel were drafted in 1929, but it was not until June of 1936 that the project was approved and a sum of $75,000 made available to the New York City Tunnel Authority for conducting certain advance investigations, for making borings, and for the submission of a report. On the basis of data contained in the latter and on continued studies, the undertaking won increasing favor; but financial conditions were becoming more and more disturbing. That fact, together with the great cost of such an engineering project and the length of time required to complete it, postponed actual beginning of the work.

It was not until June 28, 1940, that funds were appropriated. Then the Reconstruction Finance Corporation made a loan of $57,000,000 for "the plaza to plaza construction of the river crossing, under condition that the City agree to purchase the necessary real estate and that the City and Triborough Bridge Authority agree to construct certain connections in Manhattan and Brooklyn." Ceremonial ground-breaking on October 28, 1940, at the Brooklyn site of the two construction shafts, in which the late President Roosevelt participated, officially marked the start of tunneling operations. Sinking of the shafts was done by Andrew Catapano, contractor. But before telling how work on the tunnel has been done and has progressed, one should know something about the principal features of this outstanding undertaking—so little of which is yet in evidence above ground.

The Brooklyn-Battery Tunnel, like the three other subaqueous vehicular crossings built for the Metropolis, will consist of two tubes, one for northbound and one for southbound traffic to avoid confusion and, in each case, to permit two lines of vehicles to move rapidly in the same direction. Where they underrun the river, each has an outside diameter of 31 feet, as compared with the Holland Tunnel's 29 feet 6 inches. Between terminal plazas, the new tunnel has a designed length of 11,100 feet, or 2.1 miles. It is ¼ mile longer than the Holland Tunnel under the Hudson River and exceeds by more than ½ mile the length of the Queens-Midtown under the East River.

Between portals, the Brooklyn-Battery Tunnel travels under land and water for a stretch of 9117 feet, or about 1.7 miles. It traces a direct and smoothly bending course between the Manhattan plaza, a little more than 2200 feet inland from the pierhead line, and that on Hamilton Avenue in Brooklyn. The latter plaza, 3000 feet inland from the pierhead line, has been kept well clear of that borough's waterfront and the expected further development of its important shipping and allied interests. Because of the long distance between portals, ample ventilation will be assured even under conditions of densest traffic by a blower building at the Manhattan portal, a ventilation building in midriver close to Governors Island, and another ventilation building near the Brooklyn portal.

The Manhattan plaza occupies a block just north of Battery Place at the southern tip of the island where old residential structures, long in a state of degeneration, had stood in dingy contrast to towering office buildings. It will serve



vehicular traffic in a number of ways, forming, as it will, an extension of the West Side Express Highway, an elevated route for fast-motor traffic; a street-level connection; and a link in East River Drive that reaches South Ferry via South Street which parallels the East River waterfront in that section of the city.

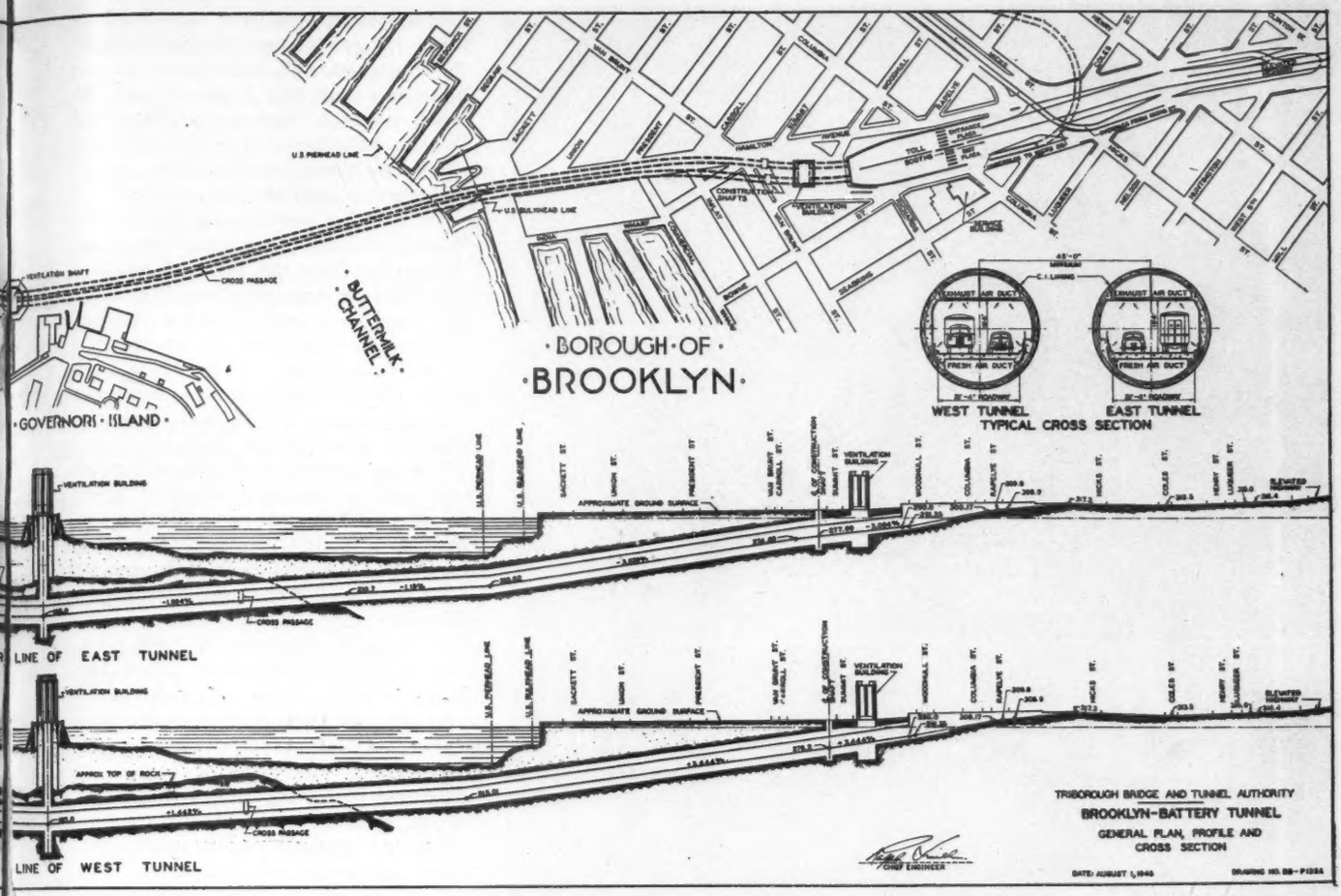
The connection between the Brooklyn-Battery Tunnel and East River Drive or the West Side Express Highway will be by underpass curving around beneath Battery Park so as to avoid the slow-moving or halted surface vehicles bound to and from the docks of ferries plying between Manhattan and Staten Island. Reference to an accompanying plan makes the layout of these links understandable. At the Brooklyn plaza there will be under- and overpasses, as well as street-level connections to promote easy and rapid movement of traffic entering and leaving the tunnel. One of these engineering features is to be an express link with the Brooklyn Shorefront Highway.

The design of the Brooklyn-Battery Tunnel is based in principle upon what was done and learned during the construction of the Holland Tunnel, which was started in 1920 and opened to traffic on November 13, 1927. That twin tube had been preceded in the Port of New York by other underwater tunnels built to facilitate railway transit beneath the Hudson, the East River, and the Harlem River; but vehicular traffic, and especially motor-driven traffic, introduced new problems, particularly that of adequate ventilation at all times. In design, construction, building methods, and facilities, the Holland tubes represented numerous innovations and betterments, and the metropolitan subaqueous vehicular tunnels that have followed typify the progress made and the skill of the men engaged in that line of work.

Before the final line of the tunnel between the Battery and Governors Island was determined by exploratory drilling, the route had been projected at a higher level which would have required excavating for some distance through mixed ground with its inherent difficulties. However, borings disclosed that the rock formation lay considerably closer to the ground surface than had been expected and that by dropping the line sufficiently an adequate cover of Manhattan schist would permit driving full-rock tunnel sections from the Battery to a point about 1000 feet south of

RECOMPRESSION CHAMBER
A workman controlling his own supply of oxygen while undergoing decompression in the hospital lock that is provided on all jobs of this kind for treating those who may become afflicted with "the bends" in consequence of "locking out" too fast upon leaving a tunnel.

PLAN AND PROFILE DRAWINGS
The plan shows where connections with existing express highways will be made at the two land terminals. In the profile drawings it can be noted how the rock line drops away abruptly a little south of Governors Island, a circumstance that necessitated using compressed-air shields in pushing the headings from the Brooklyn shore. To eliminate dealing with minus elevations, sea level was given an elevation of 300 feet.



Governors Island, where the ledge drops somewhat abruptly beneath glacial drift that forms the bottom of Buttermilk Channel. One exception to this promising outlook was discovered—an abrupt valley in the profile of the rock off Battery Park. This dipped into the projected line of the two tubes and extended below the crown or roof, and even the invert, indicating that a stretch would have to be advanced by use of the compressed-air method. As adopted, the line with its chosen gradients carries the roadways to a maximum depth of 115 feet below mean high water just abreast Governors Island, or 20 feet deeper than the maximum reached in the case of the Queens-Midtown subaqueous highway.

Originally, it was the intention to divide the work of tunnel driving into three contracts: Nos 5, 6, and 7. Contract No. 5 was to extend northward from the two construction shafts in Brooklyn for approximately 2800 feet, the advance to be in soft ground with the exception of some 300 feet of mixed face on entering the rock upon which Governors Island rests; No. 6, southward from the construction shaft in Battery Park, Manhattan, for a distance of about 2400 feet; and No. 7 was to cover the ventilation shaft in midstream and around 1700 feet of rock excavation north and south of that shaft in the Governors Island ledge. Between the specified northerly limit of Contract 5 and the southerly limit of Contract 7 was 400 feet of additional tunneling, and the contracts were to be written so that a part or all of it could be done under either. Similarly, there was 400 feet between the specified limits of Contracts 6 and 7.

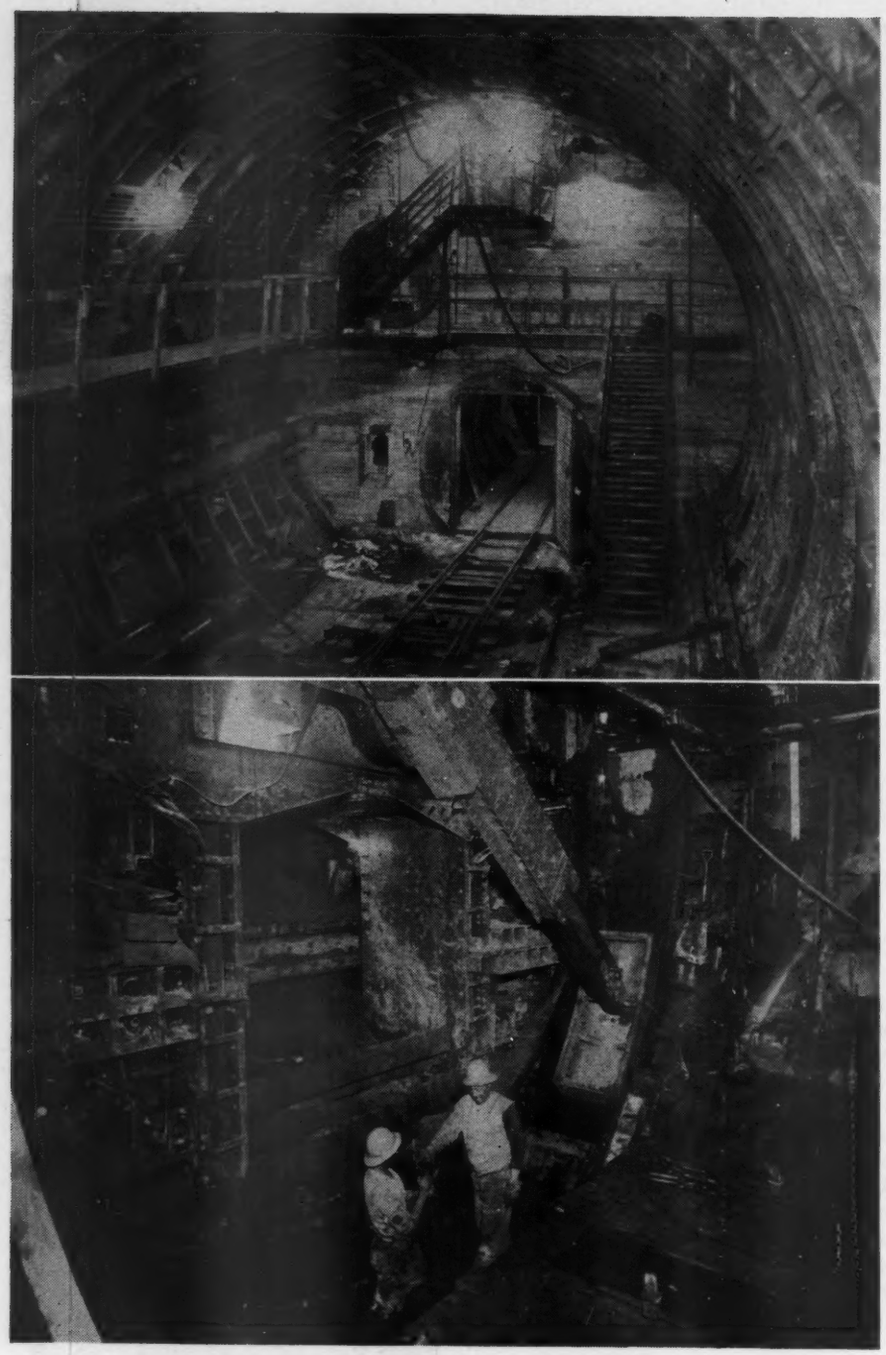
Contract No. 5 was awarded to the George H. Flinn Corporation, which began work on the Brooklyn tubes June 23, 1941. The contract price, which included the 400 feet between Nos. 5 and 7, was $13,888,000. Contract No. 6 was let to Mason & Hanger Company, Inc., at a cost of $13,948,000 and included the 400 feet between Contracts 6 and 7 and that much of the Manhattan section first planned for Contract 7. Tunnel driving from the Battery Park construction shaft, which had been sunk by A. D'Angelo & Sons, Inc., was started the latter part of October, 1941.

Because of war restrictions, Contract No. 7 was not awarded until the first half of 1946, and under its terms no tunnel driving was involved. It was limited to the sinking of a shaft to a depth of about 30 feet below the bottom line of the tubes and to the construction of the substructure on which the ventilation building adjacent to Governors Island is to be erected. In consequence, excavating on the tunnel line under Contracts 5 and 6 was extended to a common meeting point 80 feet south from the center of the Governors Island ventilation shaft. Contract 7 was let to the Grow Construction Company at a price of $3,594,580.

The contractor for the Brooklyn tunnel sections started his operations at

CALKING LINING JOINT

Air tools quickly seal openings between segments of liner rings to prevent leakage of water that might later impair the appearance of the glazed tile with which the interior walls will be finished.



CAST-IRON LINING

At the top is a section of one of the tubes driven from Brooklyn, showing how the lining is made up of successive rings of bolted-together cast-iron segments. Athwart the tube is an intermediate bulkhead, with muck lock below, man lock at the end of the catwalk on the left, and emergency lock at the top. At the time the picture was taken the pressure was equalized on both sides and the muck-lock door was open. The other view shows how a liner ring is assembled. The erector arm of the shield is putting a segment in position for bolting to its neighbors.

the two construction shafts that had been sunk by Catapano Brothers under a separate contract. Sinking of those shafts had posed a problem because of the nearness of ground water to the street surface and because it was only a few feet below the tops of the tubes to be driven there. To lower it, to control its inflow, and to dry the ground, the contractor sank three dewatering wells capable, respectively, of receiving 500, 600, and 1000 gpm. Further, well points were used during the excavation of the shafts when the ground water had been lowered about 10 feet below the bottom line of the projected tunnels.

When the Flinn Corporation took over the shafts to begin driving the twin tubes, it had to deal with the same dewatering problem and, to do so, supplemented the previous equipment and dewatering wells by a Ranney dewatering installation. That plant consisted of a shaft 11 feet in inside diameter and having concrete walls 1 foot 2 inches thick. It was located 300 feet north of the construction shafts between the two tubes and sunk to a depth of about 63 feet below mean high water. From the bottom of the dewatering shaft radiated twelve horizontal strainer pipes spaced uniformly around the circumference at a point 57 feet below mean high water. These perforated pipes were forced into the ground from the shaft by jacking. They had an aggregate length of 1083 feet, and the longest extended 180 feet south of the shaft along the general line of the tunnel area. From there to a point 120 feet north of the shaft the drainage system lies 10 feet below the subgrade of the tubes.

The dewatering shaft was equipped with two pumps each of 2200 gpm. capacity. Pumping was started on December 19, 1941, and one day later the ground-water level had dropped as much as 29 feet. Continued pumping at that shaft and at the three construction-shaft wells at the rate of 4200 gpm. lowered it to an elevation below the subgrade of the tubes to a point more than 400 feet north of the construction shafts. This level was subsequently maintained.

Instead of having to drive his two shields from the construction shafts under air pressure, with inadequate depth and weight of ground cover to balance even moderate air pressure from beneath, lowering of the ground water permitted the contractor to start his tunneling operations in free air. The shields were in position and ready for their long burrowing northward toward Governors Island early in 1942. That in the east tunnel began moving the fourth week of February, and that in the west tube followed on March 11. Advance under free air was possible for a distance of 450 feet from the starting point and at a depth of 46 feet below mean high water. Then a concrete bulkhead and lock were built about 150 feet back from where the tunnel lining had been erected, and for a period of three months thereafter tunneling was done under reduced air pressure and with pumping. At that stage a second bulkhead was constructed.

On October 30, 1942, the War Production Board ordered suspension of work on the project because of the defense needs for steel and iron. At that time the west tube in Brooklyn had been driven 636 feet and the east shield had reached a point 1215.5 feet from its shaft—less than 200 feet from the river front. Both headings were closed with concrete bulkheads; the shields and other equipment were left in place; and the tunnels were kept dry by pumping until work was resumed in 1945.

Permission to go ahead was given in September of that year; but preparations had to be made before operations could

be taken up again. Advance of the west-tube shield was started about the end of November, while that in the east tube did not get underway until January 7, 1946. By the first of May the east-tunnel heading was about 1800 feet north from its construction shaft, and the workers were under air pressure of 32 psi. The west heading, which was approximately 270 feet behind, was under a working pressure of 25 psi. Operations were then proceeding beneath the river bottom where the formation consisted of sandy clay.

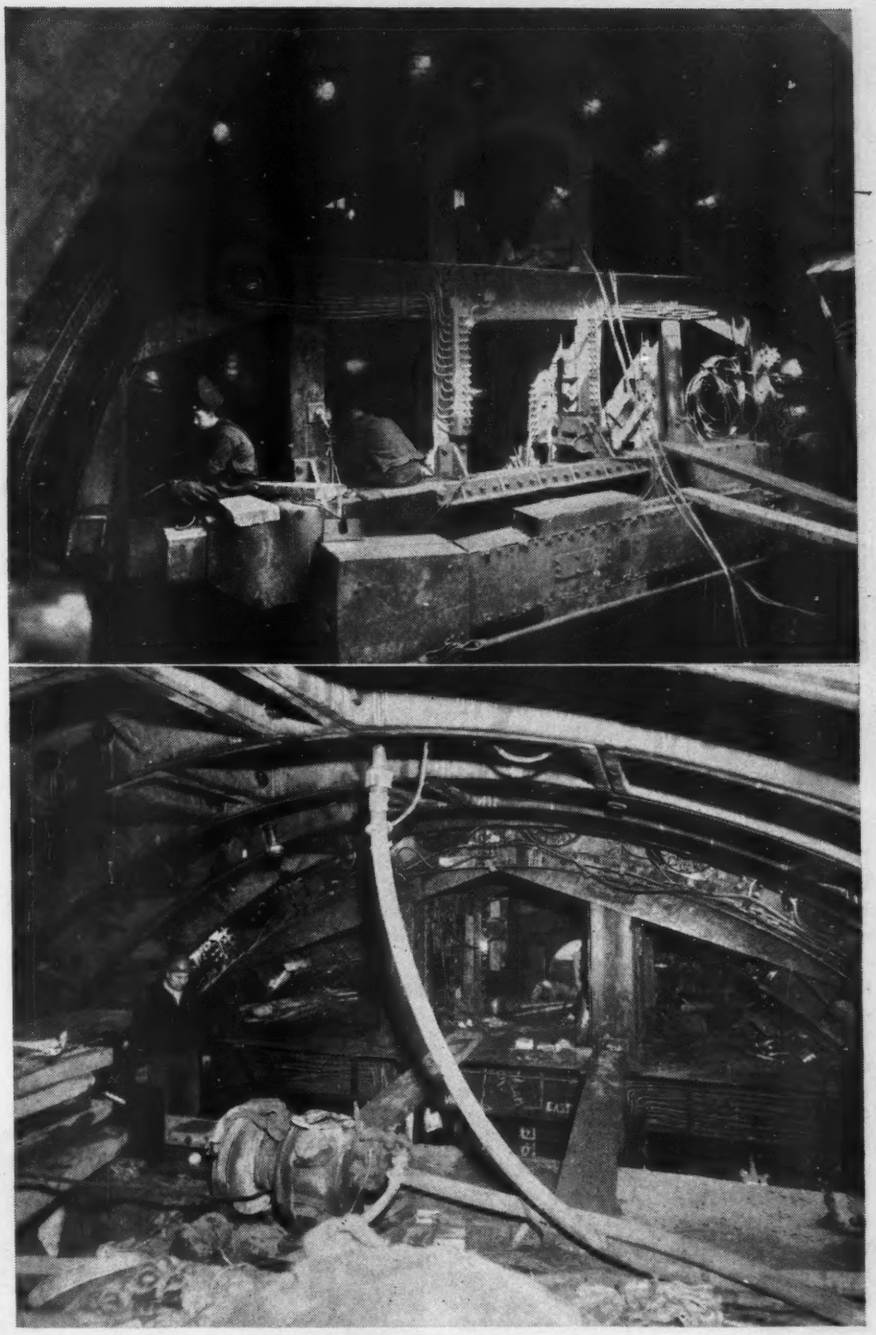
Pentration of this mass was a slow job, the daily advance being from 7 to 8 feet. The contractor had hoped when his shields were designed and built that he might be able to shove them "partially 'blind' through the stratified silt and clay under Buttermilk Channel"—that is, bodily displace some of that formation and admit only a moderate amount into the shields for transfer through a lock and thence up to the surface at the construction shaft. Instead, all muck had to be taken into each of the shields and disposed of laboriously.

Each shield weighs 400 tons and has an outside diameter of 31 feet 8 inches and an over-all length of 15 feet 10 inches from the cutting edge at the forward end back to the tail. Within the latter section is assembled and bolted to the previous ring the succeeding tunnel-lining unit, each of which has a width or longitudinal dimension of 32 inches. When the leading ring is bolted together and similarly secured to the one just behind it, the shield is shoved forward by 28 ten-inch-diameter hydraulic jacks arranged vertically in a circle just inside the shell of the shield.

The jacks, which are commonly operated at a pressure of 5000 psi., exert their thrust against the leading ring and, with that footing, push the shield into the ground. When the jacks are retracted, just enough space is left between them and the leading ring for the erection of the next liner ring, which is made up of fourteen segments—twelve "A" segments with radial joints and two "B" segments with flared ends to provide a space or keyway into which a tapered key unit fits with its wider end inside the ring. The several parts of the latter are lifted and held in place until bolted by a hydraulic erector arm, which is pivoted at the axis of the shield and can be swung around in a circle.

At each shove, a shield is advanced the width of a ring, and one completed ring remains within the tail and attached to the lining while the succeeding ring is being assembled and added to the lining. In this way only a restricted passageway remains between the shield and the leading ring through which compressed air from the heading can escape and mud or water flow inward. All or any number of the hydraulic jacks can be brought into action at each thrust and on any part of the ring, permitting the shield to be steered upward, downward, or to right or left. If there is any deviation from the prescribed course, it is checked by a surveyor before each advance and corrected at the succeeding shove. By this sytem of control the shield can be guided on a curved path, if so desired; and by suitable means, established as excavating proceeds, its course is continually checked backward to the surface where the line to be followed is fixed by visible survey marks or stations.

The tunnel driver of today can correct a shield's departure from the set course in another way—by the tapered ring, which is machined on one side and erected so that the next normal ring will correct the deviation whether up or down or right or left. And tapered rings can be deliberately used, like the segments in the elbow of a furnace smoke pipe, to give the tunnel a curving course in any direction. Also, when the concrete lining is being placed, the wall thickness top or



DETAILS OF SHIELD

At the top, welders are putting the final equipment on the rear end of a compressed-air shield. The hydraulic erector arm, which is pivoted at the center of the shield, is in horizontal position in the foreground. The numerous pipes which are visible lead to hydraulic jacks that perform various services. The other view shows the upper part of the forward end of a shield. In the foreground is a Utility air hoist that hauls and lifts materials used in connection with the operation of the shield.

BOLTING CREW

Here the bolts that hold the lining segments in place are being given their final tightening with long-handled wrenches. In the upper center may be seen the retracted plungers of two of the hydraulic jacks that push against the last ring, when bolted, to shove the shield forward a ring width.

bottom or at either side may be varied by purposely shifting the forms, thus keeping the axis of the tunnel straight so far as the observer can see.

On the front face of the bulkhead or structure to which the erector arm is secured are movable platforms that may be advanced or retracted by other hydraulic rams, and there are also heavy timber bulwarks that can be moved and forcefully held by the rams against caving wet ground while the latter is being undercut for removal so the shield can be pushed forward. The face is excavated a ring length from the top to somewhere below the spring line, and below that point the material is generally allowed to flow into the shield on a natural slope. The face is supported by breast boards about 2 inches thick, and they, in turn, are held in place by vertical timbers—called "soldiers"—that are braced by the shield platforms and face jacks.

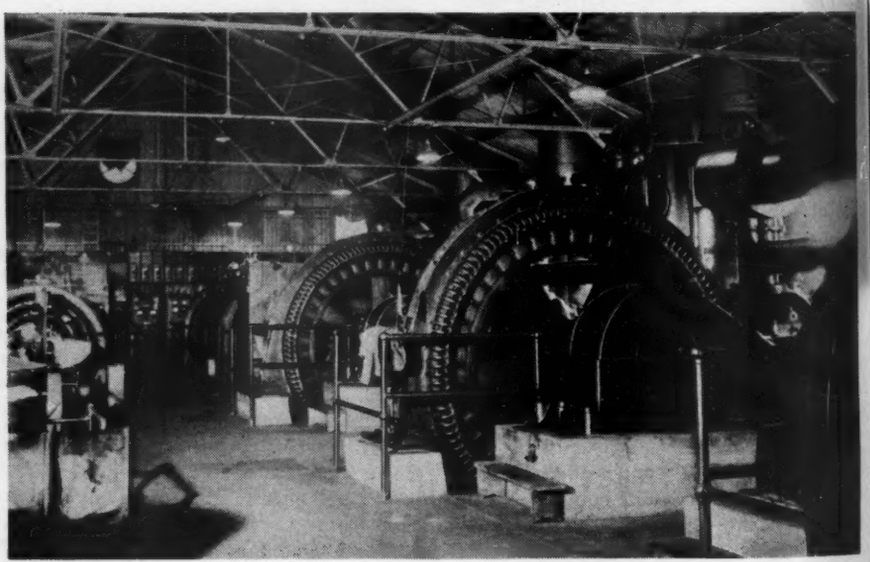
The sand hogs work in pockets that are open toward the breasting where they are under air pressure sufficient to counterbalance the hydrostatic pressure at the given operating depth. Skill on the part of the tunnel driver keeps the air pressure at the face of his shield just slightly in excess of the outlying hydrostatic pressure, thus allowing for some escapage so that the air pressure will not be great enough to force its way outward and upward and cause a violent reaction in the form of an inundation at the front of the shield. Hydrostatic pressure is generally balanced at a level about 6 feet above the tunnel bottom. This produces a dry face above that level and a wet one below it. The excess air pressure required at the top of the face is counteracted by the weight of the overlying river bed which, when necessary, is augmented by depositing on it a partly impervious blanket of heavy clay.

While the shields in Brooklyn were advancing northward in free air through the drained area and then under air pressure below built-up Hamilton Avenue, grout and pea gravel were blown into the enveloping ground by compressed air after each shove to fill any space behind the shield and immediately outside the tunnel lining. That was done to check any settlement of the earth that might cause nearby buildings to subside.

During the first stage of tunnel driving in free air the contractor's forces erected three liner rings in 24 hours, and they accomplished about as much during the early period of their work under compressed air. But when confronted with mixed ground and rock they were able to place only one ring in 24 hours. The most difficult part of the job was encountered beneath the river upon first contacting the downward-slanting ledge of Manhattan schist on which Governors Island rests. There, most of the advance required continuous and troublesome breasting operations because the lower half of the face involved excavating rock and the upper half the river bed made up of a glacial deposit. Now that the entire face is in rock, tunneling is being carried forward by bottom headings that will undergo successive enlargement until full size is reached.

The George H. Flinn Corporation has used low-pressure air for its shield work and high-pressure air for pneumatic clay diggers, paving breakers, rock drills, and other air-operated equipment. Much pumping has been required to remove water seeping into the tunnel excavations and to operate the numerous hydraulic jacks on the two shields. The powerhouse in Brooklyn is ample to meet all pumping needs; and its seven large compressors have taken care of the varying air requirements.

The second installment of this article will appear in the October issue.



BROOKLYN COMPRESSOR PLANT

Two Ingersoll-Rand single-stage compressors in the George H. Flinn Corporation powerhouse. They are among five machines that furnished 29,300 cfm. of low-pressure air for use in balancing the hydrostatic pressure of the overlying silt and water in driving the shields forward. Also in the same plant are two I-R units, each of 2030 cfm. capacity, that supply high-pressure air for operating paving breakers, pneumatic tools, and other equipment needed for the work.

Princeton University's Unique New Library

C. H. Vivian

PRECEPTORIAL CONFERENCE

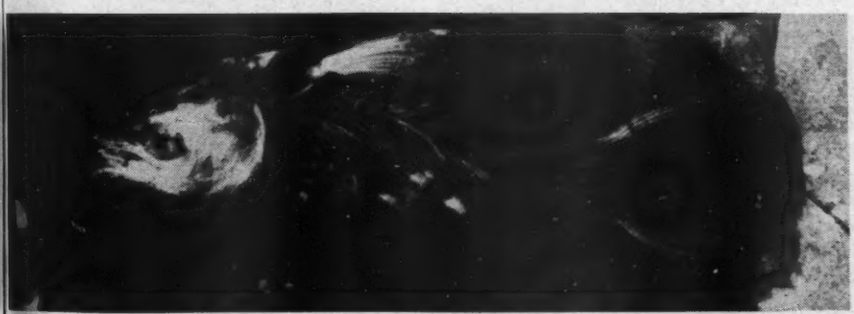
Informality is one of the features of Princeton's preceptorial method of instruction that was introduced by Woodrow Wilson when he was president of that institution. The group pictured has forsaken its regular meeting place in the professor's office for a nearby shady spot on the campus on a hot spring day.

PRINCETON UNIVERSITY, the fourth oldest institution of higher learning in the nation, is building a new library of unconventional type. Planned to implement the school's distinctive method of education that puts individual research above classroom instruction, the building will depart from the usual lines of construction and interior arrangement. More than 25 years of study and investigation preceded the actual drawing of the plans. As a result, the authorities believe they have devised a structure that will both answer current needs to greatest advantage and be readily adaptable to future changes in requirements as they may develop.

For some years a new library has been considered Princeton's most urgent need. This is because books, and more especially ready access to them, are of prime importance under the institution's scheme of instruction. The heart of this innovation is the preceptorial system that was inaugurated by Woodrow Wilson in 1905, three years after he became Princeton's president. His aim was to take the teacher off the platform and put him in informal contact with the students. In his own words, the plan "is meant to give the undergraduates their proper release from being schoolboys, to introduce them to the privileges of maturity and independence by putting them in the way of doing their own reading instead of 'getting up' lectures or 'lessons.' Their exercises with their preceptors are not to be recitatious, but conferences, in which, by means of any method of report or discussion that may prove serviceable and satisfactory, the preceptors may test, guide, and stimulate their reading. The governing idea is to be that they are getting up subjects—getting them up with the assistance of lecturers, libraries, and a body of preceptors who are their guides, philosophers, and friends."

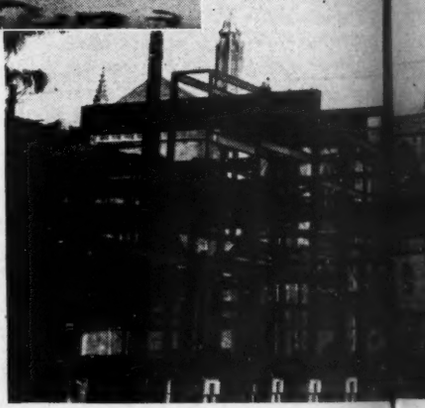
The introduction of the preceptorial system was the second step in the evolution of the Princeton plan of education. The first move was to organize the curriculum so that students might choose departments as they pleased rather than elect subjects. A definite relationship of the courses in each department was established at that time so that any combination the student might select would give him a fairly adequate knowledge of the entire field. At the same time, the number of courses was limited to the point where he would have to elect work in other departments to fill out his schedule.

Under the Wilson scheme, 50 preceptors were added to the faculty, and they soon became known as "those preceptor guys." However, this departure from traditional methods of imparting formal instruction worked well, and has continued to do so. It was designed to make a distinction between transferring information and transferring knowledge. In most schools a teacher passes out information and the student passes it back in recitations or written examinations. He may know the correct answer to a question and still not understand it or have a clear-cut idea of



OSTEOPLEURUS NEWARKI

During the excavation for the new library there were uncovered numerous specimens of small fossil fishes from rocks of the Triassic Age that were laid down probably 175 million years ago. Their scientific name is given above. Some of them are the finest of their type ever discovered and reveal details of anatomy never previously distinguishable. Knowing that Triassic rocks would be cut through, Princeton geologists watched the work for fossil vertebrates, although their searches in the case of similar rocks exposed in road cuts, quarries, and other excavations had been unavailing. This time, however, their vigil was rewarded. Most of the fossils were recovered in an area of 15x50 feet. After the first ones were found, the contractors co-operated with the scientists by digging carefully when working in the stratum that had yielded them. As a result, many more were unearthed in an unbroken condition. Most of them were in thin layers of hard shale, others in soft clay. The fossils range in length from 1 to 8 inches. The Osteopleuri had large heads, lacked bony vertebrae, and had a curious long third or middle lobe of the tail that extended beyond the end of the flat expanded part. Their lungs were calcified while they were alive and are preserved in some instances. The body was covered with oval-shaped scales from which numerous sharp spines projected. Princeton has presented specimens of the fossils to various museums and colleges in this country and abroad.



GENERAL VIEWS

An architect's portrayal of the new building, above, shows the entrance facade, with a corner of the University Chapel at the right. Called the "Springboard of Princeton's postwar progress," it has been conceived as a place where a student "may pursue his education with books and faculty at his elbow." Although it will contain 3,400,000 cubic feet of space, its true size will not be apparent because its most massive part will be underground. Planned for maximum efficiency of service and economy of operation, the structure will house the largest open-stack library in existence. It will provide room for 1,800,000 volumes and seating accommodations for 1875 persons. Despite numerous departures from the traditional layout to implement Princeton's distinctive mode of preceptorial teaching, it will have a higher ratio of book space to total cubic content than any other large college or university library in America. In appreciation of gifts from the Firestone family totaling more than $1,100,000 the building has been named the Harvey S. Firestone Memorial Library. The cornerstone was laid (top-center) on June 16 of this year by Harvey S. Firestone, Jr., eldest of five brothers who are all Princeton alumni. A partial view of the steelwork for the superstructure is at the right. The new library will replace Chancellor Green and Pyne libraries, shown at the extreme right. The former was built in 1873 and the latter in 1897. They have been joined to form one structure.

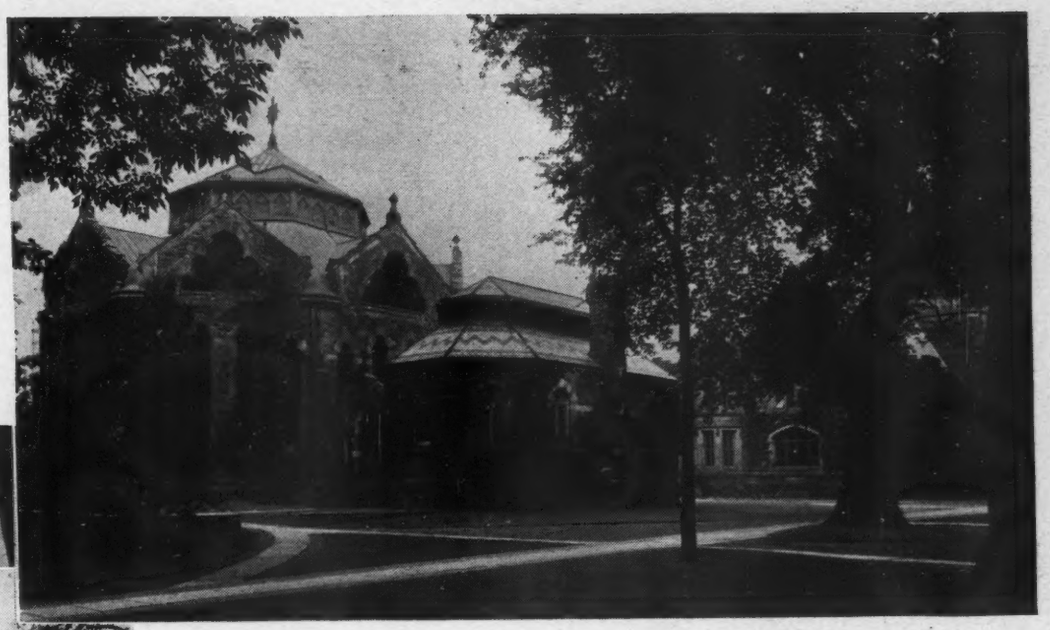
its relationship to the subject. Knowledge, however, connotes understanding. Once acquired, it remains in the mind, whereas mere information may be very transient. It was the belief that knowledge could best be built up in students' minds by making the contact between them and their teachers close and informal. This is effected by dividing classes into relatively small groups.

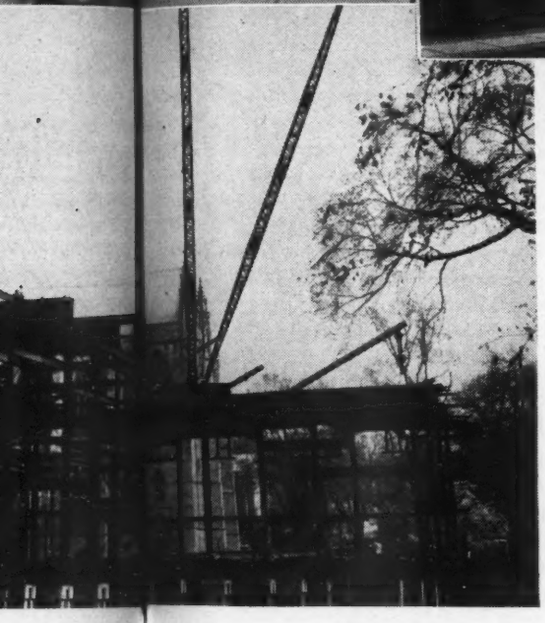
A typical preceptorial conference numbers from six to ten men and is usually conducted at a regular class hour around a table in some university room or office. Sometimes, though, it may be held at night in the instructor's home. In either case, the atmosphere is informal. Reading has previously been assigned, and the assumption is that the students have done it and perhaps even thought about what they have read. The "precept" takes the form of an open discussion, with the preceptor acting as moderator. The general pattern is that of radio programs such as "Town Hall of the Air." Each student may have his say, or challenge the statements of others. Sometimes the argument becomes heated, and it is then that a conference generally produces the best results. The students quickly learn that the more they contribute, the more they receive in return. This encourages them to read and think, and that is the purpose of the teaching method. It has been called "untying a young man from the apron strings," and Wilson's idea was that it would lead students to "read and think for themselves along great lines of study, emancipated from school methods and stimulated to use their minds outside the class room."

Thus far the plan has been applied principally to upper-class and graduate-school studies. It is not possible to introduce it extensively in the engineering or science courses, where the lines of instruction must of necessity be rather rigid. It has, however, proved so successful in the other departments that it is proposed to intensify it where it is now used and to extend it to the freshman and sophomore years. A so-called "new plan" has been put forward by Dr. Harold Willis Dodds, who has been president of Princeton since 1933.

It is obvious from the foregoing that adequate library facilities are even more important at Princeton than in the average university. During the extensive preliminary planning period for the new structure, Doctor Dodds expressed the belief that it should be "a campus workshop where the three elements of the educational process—students, teachers, and books—can be brought in intimate association." And that, epitomized, has been the aim of the library's designers.

The Presbyterian educators who founded and nurtured Princeton in its early years had a keen sense of the importance of books. In the preface of the





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school's first library catalogue, issued nearly 200 years ago, President Davies wrote: "A large and well assorted Collection of Books on the various branches of literature is the most ornamental and useful furniture of a college and the most proper and valuable fund with which it can be endowed."

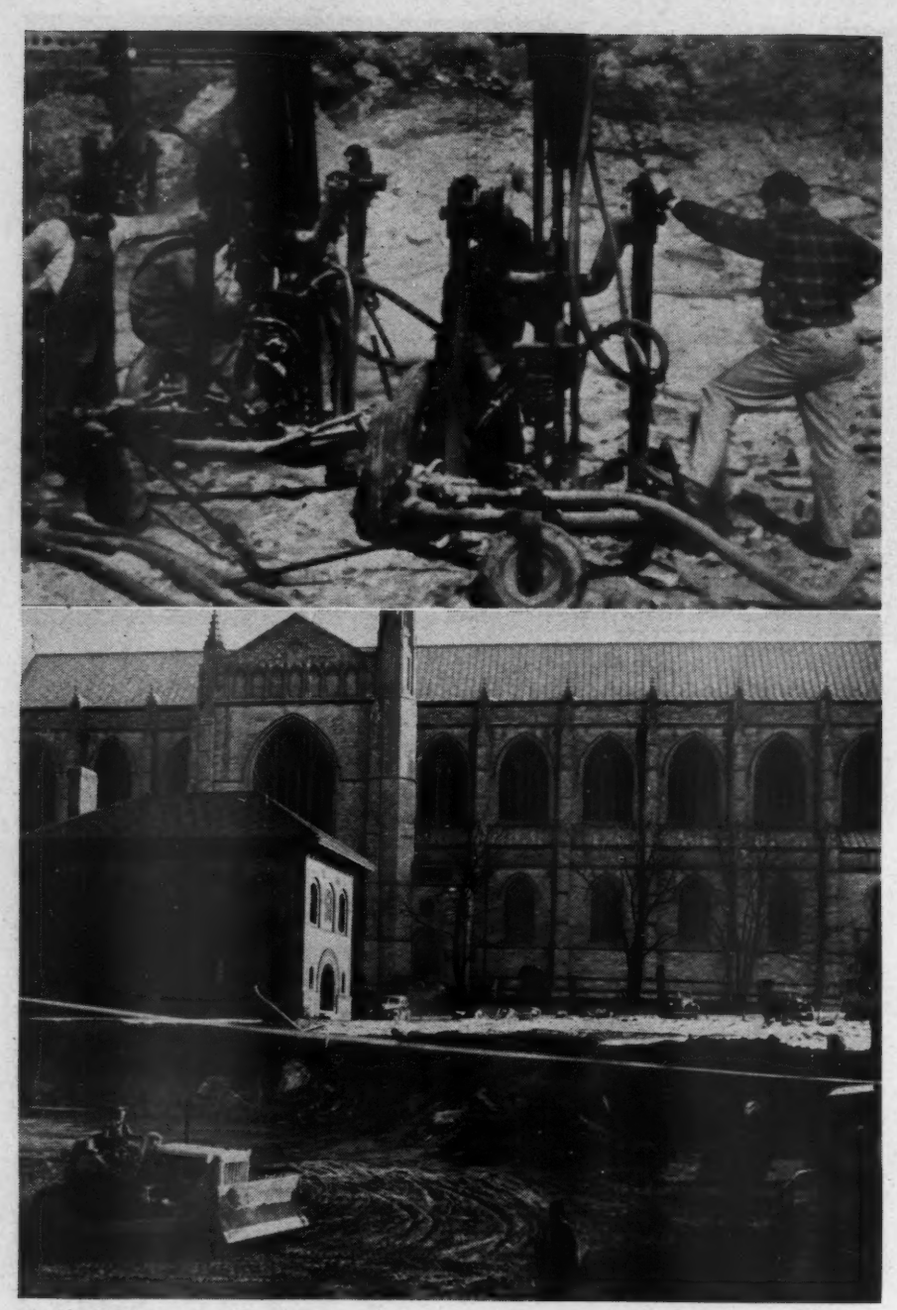
We are not informed as to the size of this original "Collection of Books," but it has multiplied many times since then. Acquisitions were slow during the first century, and in Civil War days the library numbered only 25,000 volumes. This was a critical period in the school's history, as a large proportion of its students had been coming from the South and the enrollment dropped sharply. President James McCosh piloted it through the postwar recovery years, and during his tenure of office (1868-88) he increased the library to 65,000 volumes. By the time Woodrow Wilson doffed his academic robes in 1910 to become governor of New Jersey, it had mounted to 271,000 volumes. In 1936 there were 740,000, and now there are approximately 1,000,000, exclusive of unbound pamphlets and manuscripts. Some 200,000 of these are in departmental libraries and will stay there. The remaining 800,000 volumes will be removed to the new library.

In physical size, the building will be imposing. Three of its six floors will measure 350x225 feet, and all of them together will provide some 4½ acres of space. They will provide room for double the number of books the university now owns, but even so an eye has been cast toward possible future requirements by designing the structure so that it may readily be enlarged. Gauged by the monetary outlay it will represent, the building will be equally impressive. Prior to the actual beginning of construction, it was estimated that it could be erected for $3,500,000, but interim increases in prices of materials and labor have pushed the indicated cost up to $6,000,000. This is no mean sum, but virtually none of it will be spent on non-essential embellishments. On the contrary, President Dodds has emphasized from the start that the library is designed "to serve a virile educational purpose, and not, as has too often been the case in the history of college and university construction, to provide an architectural monument."

The task of raising the required money was undertaken by a committee headed by Paul Bedford of the class of 1897. Some $750,000 was contributed from the memorial funds of the various classes, and $500,000 was given by the Institution for Advanced Study, which makes its home in Princeton and whose staff includes many notables, among them Albert Einstein. The greatest single donation came from the family of the late Harvey S. Firestone, a pioneer in the development of rubber and an intimate of Thomas A. Edison. All five of his sons are Princeton graduates. They are: Harvey S., Jr., class of 1920 and now president of the Firestone Tire & Rubber Company; Russell A., class of 1924; Leonard K., class of 1931; Raymond C., class of 1933; and Roger S., class of 1935. Mrs. Firestone and her sons contributed $1,000,000 in 1945 and added $111,543 in February of this year. In appreciation of their generosity, the trustees of the university voted to name the new addition to the campus the Harvey S. Firestone Memorial Library.

The construction of the new library coincides with the opening of Princeton's third century of existence. It was chartered as the College of New Jersey on October 22, 1746, by John Hamilton, acting governor of the state. The first undergraduates reported to Rev. Jonathan Dickinson in Elizabeth, N. J., in May of 1747. Shortly thereafter activities were moved to Newark. When a permanent location elsewhere was sought, Princeton won out over New Brunswick primarily because Nathaniel FitzRandolph gave 4½ acres of land for a campus. (It now embraces 800 acres and some 80 buildings.) In 1754 the erection of Nassau Hall was begun there, and it was occupied in 1756. The name was changed to Princeton University in 1896. The bicentennial of the founding was observed throughout the period from September, 1946, to June of this year. At the concluding ceremony on June 17, President Harry S. Truman received an honorary degree. The day before, Harvey S. Firestone, Jr., had laid the cornerstone of the new library.

It is the interior arrangement of the library that has led to calling it "one of the world's unique educational structures." The basis of the scheme followed was advanced in 1932 by Prof. C. R. Morey, and its development into final



EXCAVATING FOR THE FOUNDATION

As subcontractor, George M. Brewster & Son removed 100,000 cubic yards of earth and rock from the 350x225-foot building site. The extreme depth to grade was 31 feet, with footings for piers extending 13 feet deeper. Rock was exposed at the surface on one side, and gradually sloped to a depth of several feet under the topsoil on the other side. Three portable compressors with a combined capacity of 1450 cfm. supplied air for drilling. A 6-inch delivery main was laid all around the site, with take-offs into the excavation area as required. Eight Ingersoll-Rand Type D wagon drills were used to drill the sandstone and shale rock. Several of them are illustrated at the top. After being blasted, the broken material was loaded into trucks by power shovels and hauled to disposal areas. The lower picture shows a bulldozer at work removing topsoil. In the background is a section of the University Chapel, one of the finest of Princeton's many attractive buildings.

form has involved study and planning on the part of innumerable individuals and committees drawn from the faculty, board of trustees, and alumni. The architects are O'Connor & Kilham of New York City. R. B. O'Connor of that firm holds a Princeton degree. His associate, Walter H. Kilham, Jr., spent parts of three years visiting libraries in this country and abroad during the period the plans were being formulated. Either together or individually, Messrs. O'Connor and Kilham have served as architects for libraries at Trinity College, Hartford, Conn.; Carroll College, Waukesha, Wis.; and an annex of the Morgan Library in New York.

The outstanding departure from tradition lies in the abandonment of any distinction between storage and non-storage space, and with it the elimination of all barriers between the books and their readers. The volumes that are in general use by the various departments of study will be housed in "open stacks," freely accessible and surrounded by offices, seminars, and reading rooms. Moreover, the interior arrangement will follow the modular plan of construction —which means that it will be made up of units of space uniform in size, illumination, and ventilation, and interchangeable as to function. The basic unit will measure approximately 18x25 feet, a size that is convenient for either book stacks or seminars. Two or more units may, by shifting readily removable partitions, be combined to form large conference rooms. In all cases, the ceiling height will remain at about 8½ feet which, it has been determined, permits of the most satisfactory illumination.

As an aid to individual study, there will be more than 500 cubicles or carrels for research workers. A student's carrel will be his own private study, located amid book stacks containing the volumes immediately pertaining to his endeavors. It will be furnished with a table, shelves, typewriter desk, adjustable lighting fixtures, and all other facilities for concentrated effort. There the occupant may keep the books that concern him at the moment. He can work undisturbed, and when he leaves for luncheon or for the day he can lock the enclosure, leaving books, notes, and partially finished reports without fear of their being molested during his absence.

Scattered throughout the book stacks will be "browsing alcoves," described as "oases of light, color, and attractive furnishings" to relieve the severity of the regimentation. Some of these will be no more than open spaces for a table and chairs for occasional reading. Others will be enclosed within partition walls permitting the display of prints, maps, and other graphic aids to study. In essence, this arrangement amounts to dividing a large reading room into smaller components, located at convenient intervals among the stacks. The rooms will seat from three to eight persons each. On the stack floors, also, will be two kinds of seminars: "talk rooms," and "work rooms." The former, as the name implies, will be primarily for graduate seminars under professorial guidance, with facilities for housing only such books as may be of immediate value. A work room, on the other hand, will be a miniature library of selected materials needed for carrying on a specific research.

Another novel feature will be the placing of the first three floors of the 6-story structure partially underground. Prior to the work of excavating, the site sloped downward in a generally northerly direction, with an extreme difference in elevation of 17 feet. By giving the

NASSAU HALL

Erected in 1756, ten years after the founding of Princeton University, this structure at one time housed all the functions of the college. The final stage of the Battle of Princeton was fought around it. New Jersey's first legislature convened in the building in 1776, and the Continental Congress met there in 1783.

ground north of the area a reverse slope —southward—it will normally be possible to obtain natural light from the north on all floors. Sufficient additional light will come in on the sides to serve about half the second floor and three quarters of the third floor.

The three lower floors will be approximately 350x225 feet in area and will be known as A, B, and C, in descending order. They will be the "stack" floors. Each will be large enough to house 500,000 books and, with the open stacks, carrels, and convertible units of space that have been mentioned, will be devoted primarily to the needs of specific departments of study. Floor A, for example, will be concerned principally with the Departments of Economics, Politics, and History. Along the full lengths of two walls and sections of the other two will be offices, seminars, and other study areas. All three departments will make use of a joint conference-lounge room.

The main entrance to the building will be at ground level and have a southern exposure. While in reality the fourth of the six floors it will be known as Floor 1, and the two above will be Floors 2 and 3. Placing the entrance approximately at the structure's midheight will minimize the distance that will have to be traveled to reach the various floors either by walking the stairways or riding the elevators. Aside from the functional advantages, there was an aesthetic reason for putting the roots of the edifice deep in the earth. The library is situated in the northeastern part of the campus and adjacent to the University Chapel, one of the most beautiful of the many attractive buildings that have earned Princeton the reputation of being among the sightliest academic plants in the country. If the huge library were to be reared entirely above ground it would dominate the area and detract from the chapel and other nearby structures. It would also virtually shut off the view of the chapel from Nassau Street, the principal business thoroughfare of corporate Princeton. These objections have been eliminated by putting most of the mass of the new building below the general ground level. The stories above ground will be much smaller than those underneath. The superstructure will be Gothic in architectural treatment so as to conform with that of the chapel and will be surmounted by a tower.

Upon entering the building the visitor will arrive almost immediately at the circulation desk, the nerve center of all library activity placed conveniently to serve him. There he will find the catalogue of all the volumes at his disposal; the Union Catalogue, which lists some three million titles of books in other libraries throughout the nation; and various other bibliographies of what has been published and where it can be found.

The physical equipment that will aid the staff in its work will be the most modern obtainable. It will include a pneumatic-tube system for dispatching call slips for books to the respective

JOSEPH HENRY HOUSE

To make way for the new library, this 110-year-old brick structure was moved 450 feet to its present location between Nassau Hall and Nassau Street, Princeton's main business thoroughfare. This marked the third time it has been shifted. It was built in 1837 as a residence for Professor Henry, who has been called "The father of the American electrical industry." Two years before Morse developed the commercial telegraph, Henry had set up a wire communication system in Albany, N. Y. Upon going to Princeton as professor of natural philosophy, he strung a wire between his office and home and used it to notify his wife whether he would be home for luncheon or if he desired some sent to him. By stringing a wire parallel to but 225 feet away from this first one he succeeded in passing a current between the two by induction, thus obtaining what scientists have recognized as the first "wireless effect." Among Henry's numerous inventions was the magnetic relay, which made long-distance wire communication possible. He declined to patent any of his discoveries. He left Princeton to become the first director of the Smithsonian Institution in Washington. In 1870, Henry House was transported, brick by brick, to a new site near Nassau Hall and on its old location rose Reunion Hall. The second move came in 1925 in order that the University Chapel might be built where the dwelling was then standing. Then it was shifted as a unit, as it was this time. The house is the traditional home of the dean of the college. Its last occupant was Christian Gauss, now dean emeritus. Its new tenant will be Dean Francis R. B. Godolphin.

floors where the volumes are stored. For the present it will operate only in a vertical line, but tubes have been placed in a tunnel underneath the bottom floor and reaching to the north wall in readiness for some future time when it may become necessary to extend the library limits.

The tube system will be put in by the Lamson Corporation of Syracuse, N.Y., which is a specialist in that field, and will function on the exhaust principle. Carrier capsules or cartridges will be 8¾ inches long and 4 inches in diameter, inside. When a carrier is discharged on any floor it will switch on a signal light in the various stack areas to notify attendants in the event the station is unmanned at the moment. Books will be carried up or down, as the case may be, by a vertical conveyor and will be automatically transferred on Floor 1 to a horizontal conveyor that will deliver them to the desk where they will be handed to those desiring them.

One of the first-floor rooms will be as close a reproduction as possible of the library of the College of New Jersey as it existed in the eighteenth century. It will contain the desk of Princeton's sixth president, John Witherspoon, together with several hundred of his books and others from the libraries of Aaron Burr, Jonathan Edwards, and other Princeton leaders. There will also be an Alumni Room, with books, prints, records, and trophies portraying the history of the institution. Special collections of rare books and manuscripts, the administrative offices, a reference reading room, a reserve-book room to supply general research needs, and newly received volumes will be on the same floor.

Floor 2 will be devoted mostly to special collections, including the Gest Oriental Library of 100,000 volumes, the Woodrow Wilson collection, and displays of coins and stamps. Floor 3, with book stacks, carrels, and seminars for the use of the Department of Classics, Oriental Languages, Philosophy, and Religion, will be similar in arrangement to the three lower floors but much smaller. A lounge room large enough to accommodate the entire faculty also will be located there.

The bottom three floors are being constructed of reinforced concrete. The superstructure will have a framework of structural steel and its outer walls will be faced with Foxcroft stone, which is being quarried near Swarthmore, Pa., and cut to the required dimensions at the building site. There will be no interior supporting walls, in keeping with the aim to set up no artificial barriers between the books and their users. Instead, there will be concrete columns to help carry the load and to house lighting conduits, piping, and ventilating ducts. Adequate circulation of fresh air to all parts of the library will be provided, but for the present only the sections for the rare books will be completely air conditioned.

The Turner Construction Company of New York is erecting this notable edifice on a cost-plus-fee basis. During the past 45 years that firm has put up 2000 buildings representing an aggregate cost of more than $700,000,000. Among them have been structures for Pennsylvania and Harvard universities, and numerous churches, libraries, and museums. Ground was broken on January 2, 1946. George M. Brewster & Son, of Bogota, N. J., did the excavating under a subcontract. This involved the removal of 100,000 cubic yards of material, one-third of it rock. At the deepest point, grade was 31 feet below the ground surface. Footings for supporting piers were carried 13 feet lower.

Construction is proceeding on schedule, and it is expected that the building will be ready for occupancy at the beginning of the regular academic term in September, 1948. Princeton has traditionally been a university of around 2600 students, but in common with other institutions its enrollment has been swelled far beyond that point by the influx of returned servicemen. When normal conditions are once more restored, it will probably be slightly larger than it was before the war. With the Harvey S. Firestone Library providing seating accommodations for 1875 persons, it should answer Princeton's needs for several generations to come.

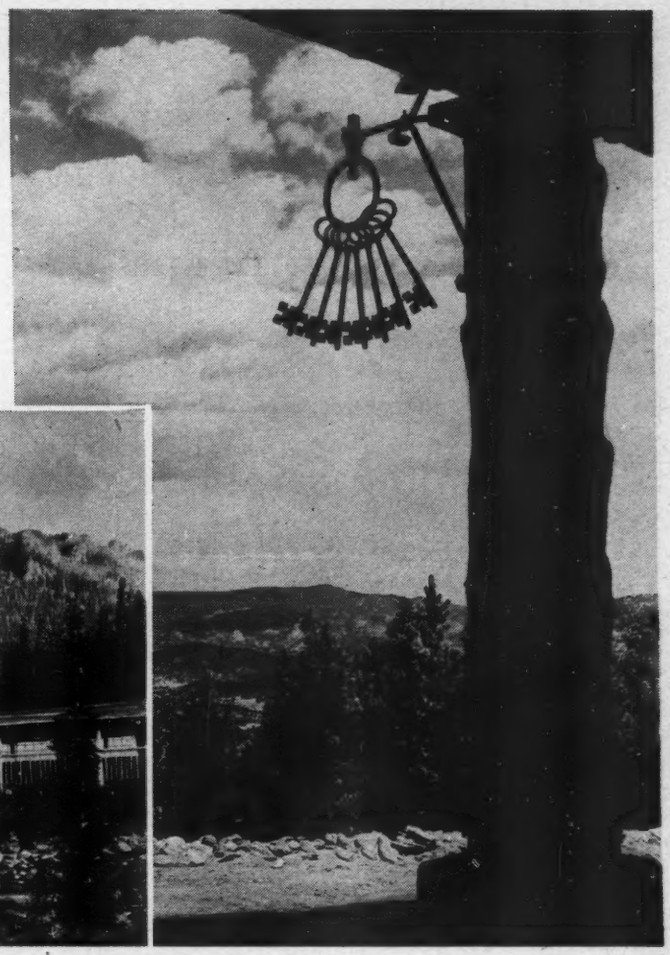
Meanwhile, in the words of Librarian Julian P. Boyd, one of the leaders in the planning of the structure, it will seem to proclaim to the thousands of students who will enter it: "This is a place where books are gathered for your study and enjoyment. It is a building dedicated to the dignity and value of knowledge and of wisdom. It exists for these purposes alone. If the architectural ornaments are beautiful or if the technical paraphernalia of librarianship intrude themselves upon you, remember that they are present incidentally or through necessity. Their purpose is to house books and to make them conveniently accessible for your study and for the enlargement of the horizons of your mind."

PREPARING STONE

Exterior walls of the library will be of Foxcroft stone, a mica schist that is quarried at Broomall, Pa. Large pieces, weighing from 4 to 7 tons each, are shipped to a storage yard about 2 miles from the building site and are there reduced in size by drilling lines of holes (below) with Jackhamers and splitting with wedges. The resulting blocks, each of the approximate size needed, are trucked to a stone-cutting shed adjacent to the building where each is dressed to fit into its place in the structure. Most of the finishing is done with Dallett air hammers, and the foreman of the crew estimates that these tools save three-fourths of the time that would be required if the work were done by hand. The stonecutters are Italians, nearly all of whom learned their trade in their native land where stone is the predominating building material. The one shown at the right is using a toothed chisel to dress the face of a block of stone that will be exposed when it is put in its allotted space.

Keys to Everything

Allen S. Park



BALDPATE INN

At the left is a view of Baldpate Inn, a rustic summer hotel perched on the side of a mountain about 1000 feet higher than the village of Estes Park, principal settlement in Rocky Mountain National Park, Colo. Over its entrance hang seven keys on a ring (right). These and the name of the hostelry refer to the novel "Seven Keys to Baldpate" that was a best seller in 1915, the year the owners of the inn homesteaded the land it occupies.

AT BALDPATE INN, a summer hotel in Rocky Mountain National Park, Colo., there is an entire room full of keys. Of every kind and of every vintage, they cover the walls and hang from the ceiling. There are more than 10,000 of them, and the collection is growing continually. Most of the keys were either left or sent there by guests or visitors, and each one is tagged with the name of the donor and a description, long or short, some in prose and some in poetry.

It all started because the Inn's owners, Mr. and Mrs. Gordon Mace, homesteaded their land in 1915, the year in which Earl Derr Biggers wrote his best-selling novel *Seven Keys to Baldpate.* It was a mystery story revolving around an old house in a remote mountain setting. It was just such a locale as the Mace acres, so they called their place Baldpate, and when they built the hotel in 1917 they christened it Baldpate Inn. Over the driveway at the front door they hung a large replica of a bunch of seven keys, which was inspired by the fact that seven characters in Biggers' story turned up with keys although there was supposed to be only one in existence.

In 1922 the Maces conceived the idea of asking their guests to send them keys, and began furnishing them with tags to be used in forwarding them. Keys gradually started coming in, and soon there was a sizable nucleus of the present collection. By the time World War II was at its height they had 7720 keys, and a separate room just off the lobby of the inn had long before been set aside for displaying them. All had been acquired without any special publicity. Then one of the motion-picture newsreels based a short on the collection. That was shown to our servicemen and women all over the world and precipitated a veritable deluge of keys. They began to arrive from here, there, and everywhere, swelling the number to more than 10,000.

There are keys of many sizes and materials. The largest is of wood and was sent by two young men of St. Joseph, Mo. The smallest is scarcely ½ inch long. There are keys of most of the known metals, including one of Colorado native metals that was given by the Colorado School of Mines. A retired railroader presented one made of metal from the bell of an old Santa Fe Railroad locomotive. There is an ivory key that was used in early Egypt, and one from a neon-sign man that is fashioned from glass. Among the numerous wooden keys is one whittled from a timberline tree on Long's Peak, the 14,255-foot eminence that graces the skyline west of the inn.

Many of the keys were donated by well-known people. Gipsy Smith, the revivalist, sent one from the Teikoku Hotel in Tokyo. The late Clarence Darrow, leading criminal lawyer, was one of the first guests to offer a key. Charles E. Mace, brother of the inn's host and official photographer for Gen. John J. Pershing during World War I, contributed keys from significant battle points in that conflict. Mr. Biggers left a key, tagged with the following inscription in his own handwriting: "This is the original key to Baldpate—all the rest are imitations. The old man gave it to me the day before he died." The words allude to the plot of his story.

The Biggers novel was dramatized by George M. Cohan, who played the leading role long and successfully. When he

THE KEY ROOM

Two views of the room that contains 10,000 keys of every type and description and from the ends of the earth. The lower picture shows the fireplace, with a large keystone contributed by one of the guests.

appeared in Chicago on November 21, 1938 (in another play), Mayor Edward Kelly gave him an engraved key to the city. That is now in the Mace collection. "Seven Keys to Baldpate" was the first talking motion picture in which Richard Dix appeared, and the key he used was donated by him to the inn. Jack Benny and Mary Livingston were guest artists at a radio version of the play and they, too, added keys.

In the collection are hotel-room keys from the world over, including the Castle Harbour in Bermuda, the Ritz in Paris, the Grand in Copenhagen, the old Waldorf-Astoria in New York City, and the former Old English Hotel built in nearby Estes Park by Lord Dunraven long before the area was a national park. James O. Stevic, Denver postmaster, sent a hotel-room key with a history. A man returned it to a Denver hostelry with a note saying he had carried it off eighteen years before. There was ten cents postage due, and after it was determined that the key wouldn't fit any of the locks in the building, the hotel proprietor refused to pay the charges. When the mail carrier brought it back to the post office, Mr. Stevic dug into his pocket for a dime and forwarded the key to Baldpate.

Many of the keys concern famous places, objects, or events. There is even one from the United States Capitol in Washington, D. C., donated by W. R. Eaton, former congressman from Colorado. He obtained it from David Lynn, architect of the Capitol, who had to get an official order authorizing him to release it. There is a key to the Royal Chapel in Westminster Abbey, and one that opens a side-gate entrance to Buckingham Palace. Also in the collection is the key to the fire-alarm box in Chicago that was used to turn in the alarm of the disastrous 1871 fire. The box was at DeKoven and Desplaines streets.

Another key would admit one to the house in Bardstown, Ky., where Stephen Collins Foster wrote "My Old Kentucky Home" and other immortal songs. A

key that dates from 900 A.D. fits a lock in the crypt where Ibrahim Pasha is entombed with the caliphs and where many members of the royal family of Egypt are buried. Believed to be the oldest of all is a hand-made key obtained from Ahmed el Malusi of Tetuan, ancient capital of Spanish Morocco. A key to the east gate of the largest mohammedan mosque, which faces the Great Pyramid of Gizeh, is 500 years old. There are keys to Nebraska's former and present capitol buildings, and one to Mozart's wine cellar. Upon seeing the latter, a woman visitor to the inn is reputed to have exclaimed: "Oh, was he here?" On a par with this remark was one by a lady who, upon being told that most of the keys had been left by guests, responded: "My, aren't people forgetful?"

Together with other keys having to do with unlawful acts, Baldpate Inn has one to the Southern Bank of Kentucky, the first bank robbed by Frank and Jessie James. A surprisingly large number of people have contributed jail keys, but the Maces never ask guests how they came by them. There are keys that give entry to many college buildings, including one for the door of the first building of the School of Mines at Columbia University, as well as emblem "keys" such as Phi Beta Kappa and Kappa Kappa Gamma worn by members of college societies and fraternities.

Numerous keys pertain to the field of transportation. Among ships' keys is one from the German submarine *Deutschland*, which made two trips through the British blockade during World War I, putting in at Atlantic Coast ports to obtain vitally needed materials before we entered the conflict. There is a key that was cast from metal that was carried as ballast by the balloon *Explorer I* when it reached a height of 57,000 feet in 1934. It took off at Rapid City, S. Dak., and landed in a cornfield near Loomis, Neb. The Burlington Lines presented a key of stainless steel from the original "Burlington Zephyr," which initiated diesel-locomotive streamlined passenger service in the nation. Another is from the Union Pacific's "City of Denver" streamliner. There is also a key from the first United Air Lines Mainliner plane routed through Denver on May 15, 1937. Paul E. Johnson, an airmail pilot, dropped a key by a miniature parachute while flying over the inn. Cunard-White Star line officials sent a key from the liner *Queen Mary* following her initial visit to New York on June 1, 1936.

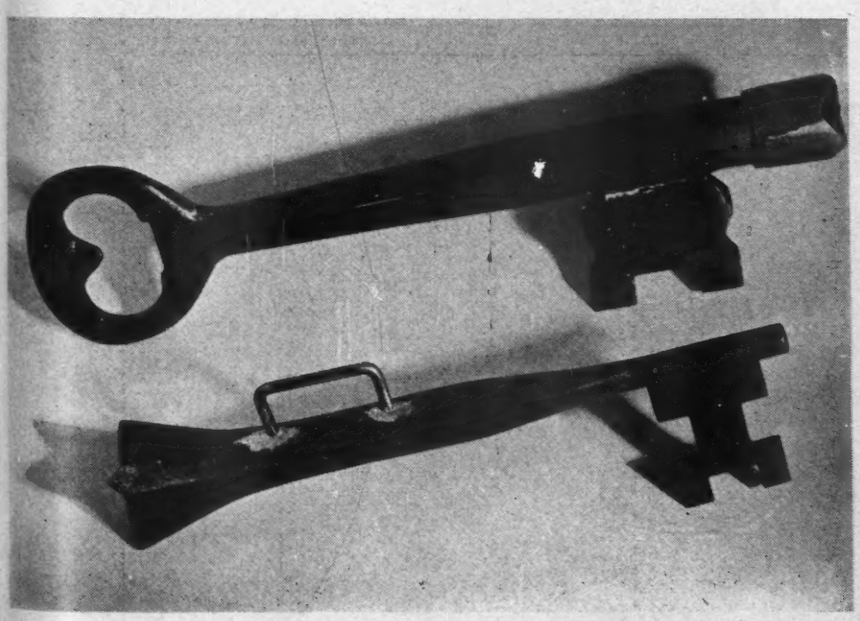
Keys other than door keys are in the collection. Watch and clock keys, some old and some new, are numerous, and included are keys to cash registers. A printer gave a quoin key used to lock forms for presses, and a stenographer contributed a shift key from a typewriter. There are cotter keys, flywheel keys, keys of the kind that open sardine cans and soldiers' K rations, and also a turnkey, an instrument by which teeth were pulled a century ago. Among the piano keys are seven from the first instrument to cross the plains to Denver in a covered wagon.

Many persons have donated symbolic keys such as the "key to happiness"—a ruler of gold engraved with the Golden Rule. Someone sent an old ox yoke that had been used by pioneer travelers and came placarded "The Key to the West." There are various artistic representations of keys, including a plate decorated with a design of seven keys. It was given by a former governor of New Mexico and his wife, Mr. and Mrs. Sotero Montoya. Other donors have played upon words such as whiskey, monkey, donkey, turkey, and darkey to bring their contributions into the category of keys.

Many objects have been converted into representations of keys in order that they might have places in the collection. Among these are two keys made from rock-drill steel that had seen service on construction jobs in the region where the inn is located. One piece had been employed for drilling blast holes during the building of the South St. Vrain Highway in 1936. This scenic route enters Rocky Mountain National Park from the south and passes close to the hostelry. The contractor, Platt Rogers of Denver, presented the key to the Maces.

The other key was formed from the drill rod that completed the final portion of the final hole for the last blast in the Alva B. Adams Tunnel, which penetrates the main range of the Rocky Mountains. This 13.1-mile bore—the longest ever driven from only two headings, will carry western-slope water through the mountains to irrigate farm lands on the eastern side. The two drilling crews met on June 10, 1944, at a point 44,994 feet in from the east portal, where the final round was put in by S.S. Magoffin Company men, Denver contractor on the east end. James R. Pierce, Magoffin blacksmith, converted the steel into a key. On the end of it is screwed one of the Ingersoll-Rand Jackbits that was used in drilling the final round. The key was added to the collection by Frank Purvis, superintendent for the Magoffin forces on the job.

There is a special reason why these two drill-steel keys are of great sentimental interest to Mr. Mace. Prior to homesteading the land where the inn stands he worked for sixteen years for the J. George Leyner Engineering Works near Denver. It was there that Leyner, about 1896, developed hollow drill steel. By thus providing a means of sending water and compressed air through the steel to clear away rock cuttings at the bottom of a hole he made it possible for the first time to utilize hammer-type rock drills, of which he was a pioneer manufacturer. As a result, hammer drills came into universal use and the speed of drilling rock was greatly increased. The steels of which the two keys are made is of this same hollow type that is still known in many mining areas as "Leyner steel." By the same token, many old-time miners continue to call hammer-type drifter drills "Water Leyners."



DRILL-STEEL KEYS

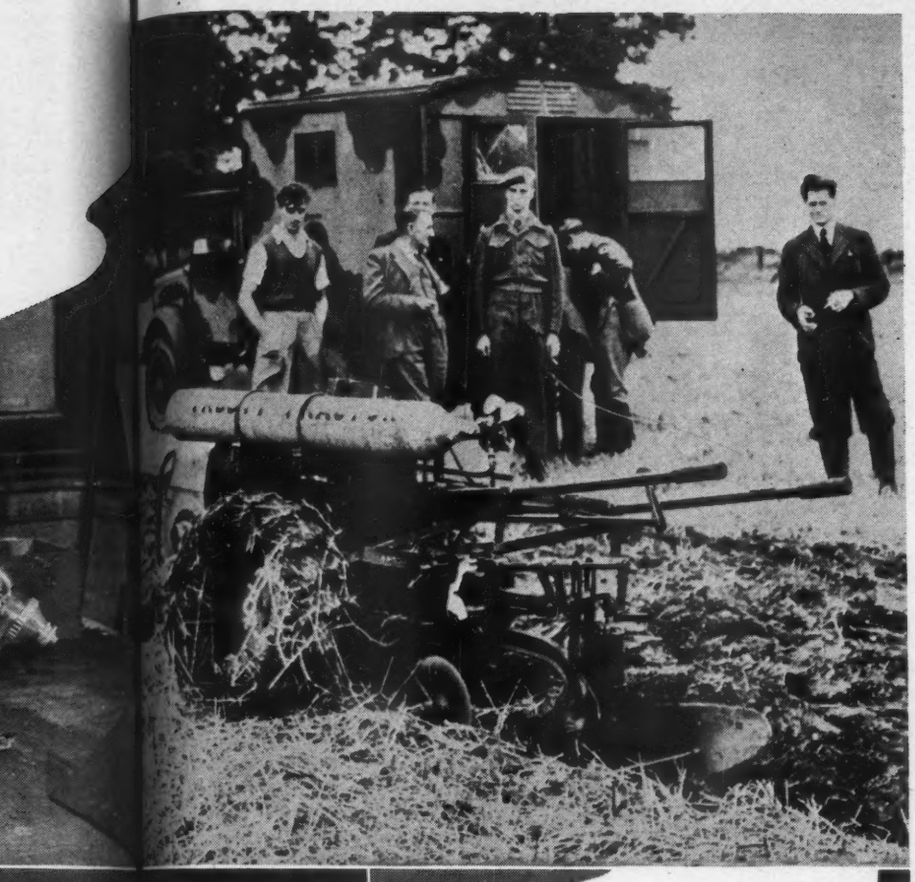
These representations of keys were made from pieces of hollow rock-drill steel. The lower one was used during the construction of the scenic highway that passes near the inn. The other one helped drill the last hole of the final round blasted in the Alva B. Adams Tunnel through the Continental Divide. The east portal of that 13.1-mile bore is about 3 miles from Baldpate Inn.

Inserting wiring by hand is one of the most expensive operations in manufacturing radio sets. To overcome this, the Promenette Radio & Television Corporation of Buffalo, N.Y., sprays it in place with air. A mask with openings corresponding to the desired circuits is first laid on the sets plastic chassis into which grooves for the wires are thus sandblasted. Molten copper with a zinc or aluminum primer is then applied through another mask with a metallizing gun, using pressure of 60 psi. The picture (right) shows the metallizing gun and mask.

WIDE WORLD PHOTO

It is claimed that an automobile can be washed, polished, and dried in one minute by an apparatus developed by the Minit-Man Auto Wash Company of Detroit, Mich. Washing is done by revolving brushes and water that contact all car surfaces. Endless floor belts spin the wheels to assist in cleaning them. From the washing station the auto is towed to the drier (above) where air is blown on it at high speed through ducts, removing the water and drying the surfaces in a few seconds. Air is supplied by the motor-driven blower shown at the upper-right.

Right—For use in connection with its high-speed band saws widely employed for cutting nonferrous metals and plastic materials, the DoAll Company of Minneapolis, Minn., has introduced a spray lubricator that operates on air pressure from plant distribution lines. The spray head straddles the saw blade and directs a mist of lubricant-coolant against the teeth from each side, forcing it into the cut. The liquid is drawn from a 1-gallon container mounted on the side of the machine and is metered as desired by means of a valve and sight glass. So little fluid is applied by this spray method (1½ quarts per hour) that no mess is created on the worktable or the material being cut.



Left—The man at the right is controlling a British-made tractor plow by radio. He transmits impulses to sensitive electric relays which, in turn, actuate compressed-air servomotors that operate the controls. The tractor can be made to go straight or to turn right or left. At the end of a furrow the plow can be raised. Compressed air under high pressure is stored in the flask mounted on top of the machine. Because it is so light, this unit is said to operate all day on the fuel a conventional tractor consumes in one hour.

ACME PHOTO

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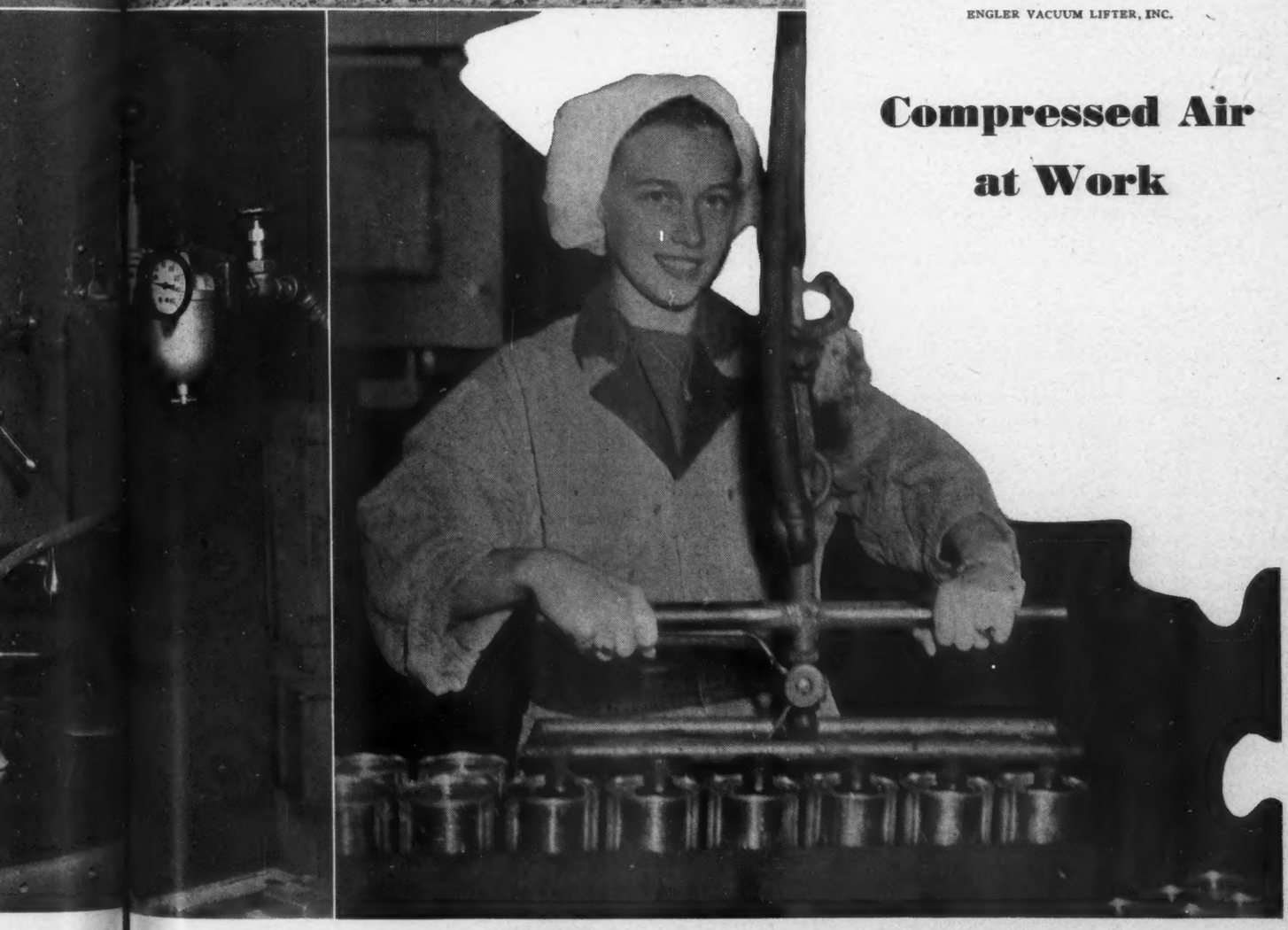
The young lady shown below is about to pick up twelve cans of vegetables that have just been delivered from a closing machine. A rubber cup, to which vacuum is applied by means of the hose, fits on the top of each can. A rope (behind the hose) passes over a pulley overhead and is counterweighted to balance the 20-pound load and make it easy to transfer it to retort crates. There is a trigger release on the handle. Formerly moved by hand, four cans at a time, this was a wearing task. Vacuum of 16-18 inches is induced by a pump, the requirement being about 6 cfm.

ENGLER VACUUM LIFTER, INC.



Compressed Air at Work

Editorials

BROOKLYN-BATTERY TUNNEL

THE insular character of the Borough of Manhattan, one of the five geographical components of New York City, has reacted both to its benefit and detriment. It has given it an extensive shoreline without which it could never have attained its preëminent position among world ports. Inasmuch as most of its early commerce was water-borne, its detachment from the mainland was then a decided advantage. The spacious harbor, the Hudson River, and then the barge canal to the northward and westward served to move goods to and from the island at low cost and made it the center of our import and export trade. Such intercourse as was necessary with neighboring land areas was carried on by aid of rowboats and sailing craft.

As the city grew beyond the confines of Manhattan, and settlements were established on Long Island, Staten Island, and in New Jersey, steam-driven ferryboats appeared to meet transportation needs. When they no longer sufficed, the Roeblings electrified the world with their daring engineering achievement of spanning the East River with the Brooklyn Bridge. It was opened to the awed populace in 1883 and paved the way for the Williamsburg, Manhattan, and Queensboro spans. The broader Hudson River, however, had no such crossing until O. H. Amman, chief engineer of the Port of New York Authority, executed the George Washington Bridge in 1931.

Meanwhile, intrepid engineers had burrowed tunnels underneath some of the waterways. As early as 1874, DeWitt C. Haskin had attempted to drive tubes under the Hudson, but it was not until 1908 that the tremendous financial and technical obstacles were overcome through the combined business acumen of W. G. McAdoo and engineering skill of Jacobs and Davies. Mr. Jacobs, who had come here from England, had previously demonstrated the effectiveness of the compressed-air-shield method of tunneling by excavating a small bore underneath the East River to carry gas. The McAdoo twin tubes and the Pennsylvania Railroad tunnels that were started in 1900 were for rail transportation. The construction of subways also was begun in 1900. In the years that followed, numerous tubes were driven underwater to provide connections with the boroughs of Brooklyn, Queens, and The Bronx.

When the automobile arrived on the scene, new problems appeared. Many of Manhattan's streets had to be revamped and express highways built to accelerate traffic. More bridges and subaqueous tunnels were needed to connect with through routes. The Triborough, Whitestone, Goethals, and other spans were erected. In 1920 work was launched by Clifford M. Holland on the first vehicular tubes between New York and New Jersey. He didn't live to see their completion in 1927, but they were named for him in recognition of his devotion to the project. Another Hudson vehicular tunnel—the Lincoln—came next, and then the Queens-Midtown Tunnel. Even all these facilities, plus the numerous ferries that ply the waters, have failed to provide free flow of traffic for New York's million automobiles and the sizeable number of visiting cars. That is why sand hogs and hard-rock tunnelers are again burrowing, and this time under the harbor waters between Manhattan and Brooklyn.

Subaqueous boring is an old story to New York construction men, but it is still ticklish business that must be thoroughly planned and meticulously executed. The Brooklyn-Battery Tunnel encountered geological problems that called for even more care than usual. At one end it is in rock that is none too thick or stable overhead for comfort, while at the other end it pierces silt and mud. Knitting the oppositely advancing sections together with precision and security was a man-size job that has now fortunately passed through the critical stage. Credit for skillful and efficient performance of hazardous work is due all those who have had a part in conceiving and carrying out this momentous engineering undertaking.

BIRTHDAY OF U. S. IRRIGATION

MODERN irrigation in the United States is an even 100 years old. The Mormon pioneers initiated it in July, 1847, when they dug a ditch near Great Salt Lake to divert water from a creek to their newly planted potato patch. Since then irrigation has become a vital instrument in the development of lands comprising one-third the area of the country and one-fifth of its population.

To produce crops successfully it is necessary to supply the soil with from 20 to 25 inches of water, and it must be well distributed throughout the growing season. Sixteen of our western states cover 740 million acres having an average annual precipitation of less than 20 inches. Twenty percent of this land receives less than 10 inches of water in an average year. The deficit must be made up by impounding and distributing surplus run-off water. Thus far, only 22 million acres have been irrigated—a mere 3 percent of the total—and half of those acres are still inadequately watered.

Even so, approximately 40 percent of all the water that runs off in surface streams is now being utilized. In other words, if all the available stream water were conserved and distributed, there would be only enough to meet the shortage in the case of the 22 million acres now being irrigated and to supply an adequate quantity for an additional 22 million acres. This means that only about 6 percent of the land can ever be brought to full crop production.

In the beginning, settlers merely diverted water directly from streams to low-lying lands. As higher lands were brought under cultivation, it became necessary to tap the waters farther upstream and to build longer canals. To insure a supply during the late growing season, when stream flows diminished, storage reservoirs had to be constructed. These were filled during the spring floods and drawn down later as needed. As more extensive works were required costs went up, and there came a time around the turn of the century when farmers, working singly or in groups, had about reached the limit of their ability to finance such projects. It was apparent that government help would have to be provided, and this was made possible by the creation, in 1902, of the U. S. Bureau of Reclamation upon the recommendation of President Theodore Roosevelt. Since then, bureau-built facilities have supplied water for growing five billion dollars worth of crops—a sum more than five times the cost of the construction projects involved.

Currently, the bureau has a long-range program which contemplates the expenditure of 1½ billion dollars to harness western rivers for irrigating water, to produce power, to control floods, and for other incidental benefits such as recreation facilities and the conservation of wild life. The schedule for the 1948 fiscal year calls for 195 million dollars worth of work, but it will have to be curtailed unless Congress appropriates an additional 36 millions.

Reclamation is not boondoggling. From its inception, the bureau has been run on a businesslike basis. Farmers sign contracts in advance of construction that provide for repayment of money spent for irrigation. Where power-generation features are included, the balance of the cost is returned to the Government through the sale of electricity. Because virtually all our beet sugar and an appreciable proportion of our meat and many other food products come from these western irrigated lands, all of us are affected by the bureau's activities.

This and That

"Steam" from Dry Ice

To obtain the effect of swirling clouds of steam desired for a series of window displays, Lord & Taylor, one of New York City's fine department stores, made use of dry ice and compressed air. Two hundred pounds of the solidified carbon dioxide was placed on a sheet of glass each morning, and the white vapor given off by it was blown about by compressed air at 2 pounds pressure directed against the block from opposite directions by means of two hose lines.

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Shot Peening Award

For originating the technique of shot peening to harden and increase the durability of metal surfaces, F. P. Zimmerli, of Detroit, Mich., will be given the 1947 Albert Sauveur Award by the American Society of Metals. The method is widely used in hardening metal parts of machinery ranging from aircraft and automotive engines to turbogenerators. It was described in our January, 1947, issue. About twenty years ago Mr. Zimmerli conceived the idea that shot peening would increase the fatigue life of springs, and the company with which he was associated first applied it for that purpose in 1929. The citation states that, "In many cases, the application of the knowledge we now have on the subject of surface stress is dependent on the extensions of the original work, but is nonetheless based on Zimmerli's early investigations." Shot peening is done by propelling steel pellets against a metal surface with a stream of compressed air, the technique being similar to that of sand or shot blasting. Mr. Zimmerli is chief engineer of the Barnes-Gibson-Raymond Division of the Associated Spring Corporation, Detroit. He is a graduate of the University of Michigan, where he formerly taught.

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Lincoln Invention Revealed

An old and scarce U. S. Patent Office publication owned by the William L. Clements Library at the University of Michigan reveals that Abraham Lincoln was granted a patent on May 22, 1849, for an invention designed to ease river boats over shoals and sand bars. As described in the patent application written by Lincoln's law partner, William H. Herndon, the gist of the scheme was "to attach a kind of bellows on each side of the hull of a craft just below the water line; and by an odd system of ropes and pulleys, whenever the keel grated on the sand, these bellows were to be filled with air; and thus buoyed up, the vessel was expected to float clear." It is said that Lincoln conceived the idea after being a passenger on a Great Lakes boat that assisted another vessel in getting off a sand bar. Being an expert whittler, the inventor fashioned a wooden model of his innovation with a jacknife. The model is still in the Patent Office.

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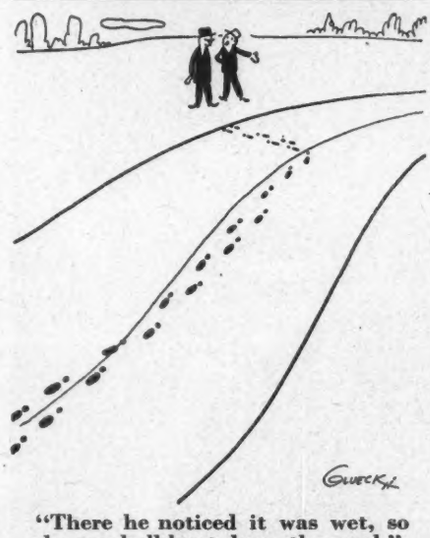
Small Horses Needed

All riding horses for police service in the British West Indies since 1927 have been shipped there from Canada. Small animals weighing from 900 to 1100 pounds are selected for the purpose because they eat less than larger ones. This is important in view of current prices in the islands of eight cents a pound for oats and six cents for hay. Recently three mounts were sent to the Commissioner of Police for Barbados and twelve to the head of the force in Trinidad. The horses are purchased by the Dominion Department of Agriculture from breeding stations that it has helped to maintain in the Province of Ontario for the past 25 years.



"There he noticed it was wet, so he ran hell bent down the road."

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Famous Rand Mine Closing

Rising mining costs have reduced profits of all South African gold mines and even forced some of them to close. The latest victim of these economic conditions is Van Ryn Gold Mines Estate, which curtailed operations on July 1 and announced its intention to close down entirely within a few weeks. The Van Ryn began crushing ore in 1892, and the present company dates back to June 22, 1894. Up to June 30, 1946, a period of 52 years, it had produced 22,482,607 tons of ore with a yield of 4,860,462 ounces of gold, valued at 25,013,632 pounds sterling. Dividends of 4,082,000 pounds sterling were paid, equivalent to 933 percent on the invested capital. In June, 1947, the mine was employing 370 Europeans and 3161 Natives. For some years past, the ore has averaged less than $4 in gold per ton, and working costs have gradually increased until no margin of profit is possible.

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Better Phone Wire

An advertisement of the Bell Telephone Company of Nevada in a mining paper in that state tells of a new steel wire so strong that the number of poles needed on rural telephone lines can be cut nearly in half. With the wire previously available, poles were generally 250 feet apart, whereas the new product permits placing them on 400-foot centers and more. This will obviously make scarce materials go farther and at the same time speed up construction. The improved wire, which is especially applicable to rural service, was developed by the Bell Laboratories. The company also announces that rural subscribers may expect fewer people on their lines and the gradual replacement of crank-type phones with modern instruments like those common in urban communities for some years.

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Flood Proof Motors

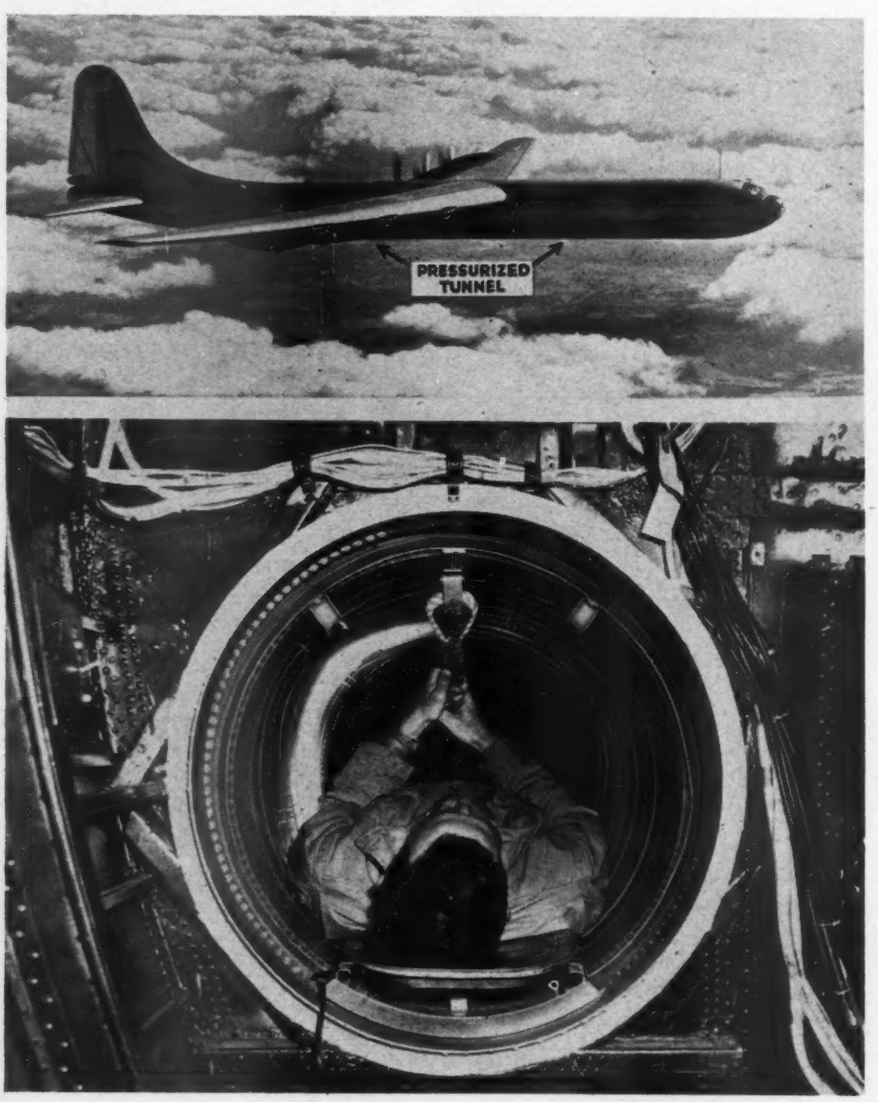
General Electric Company has supplied Crown Zellerbach Company's paper mill at West Linn, Oreg., with six 2300-hp. synchronous motors that are protected against complete submersion. They will drive wood-pulp grinders that are normally in the dry but that may at times be covered with water, since the mill is located on the bank of the Willamette River, a stream that sometimes rises 40 feet during the spring thaw. On those occasions the mill has to suspend operations. The motors are completely inclosed by reinforced-steel end plates with ventilating holes which will be open while the motors are running but will be sealed during flood periods. As a further precaution against damage, compressed air will be blown into the motor frame through a pipe connected at the top of each casing. This will serve to maintain pressure within and exclude the water.

Machine Removes Scale from Welded Axle Housings

AS A RESULT of processes that were developed during the war, an automobile manufacturer has been able to save materials and machining costs by substituting a stamped and welded tube for the conventional cast and machined rear axle housing. This change, however, was not effected without difficulties. When the halves were seam-welded together a scale formed on the inside of the tube and it was feared that it would eventually flake off and mix with the differential-gear lubricant to form an abrasive that would harm the gear. When high-pressure sprays were found to be ineffective, the concern turned to the Howard Engineering & Manufacturing Company for a mechanical method of removal.

The machine that was developed works automatically and is equipped not only to loosen the scale but to wash the inner and outer surfaces. The work is carried through it on a conveyor belt with an indexing arrangement that stops each housing as it arrives at the first station. There a steel brush is pushed into it by a pneumatic cylinder and, as it revolves, a cleaning solution is sprayed in and around the wires as well as the tube's exterior, cleansing the walls and flushing away the scale and other foreign matter. After a predetermined interval the air cylinder retracts the brush into a cabinet, where it remains when not in use. Then the conveyor moves to the next stop where the housing is dried inside and out with blasts of hot air.

During the successive operations the work is held in correct position. Movement of the brush, which is connected by a shaft to the pneumatic cylinder, is regulated by valves which are synchronized to function when the indexing mechanism goes into action. Metering valves in the air-supply line permit close control of the brush travel, and air ranging in pressure from 60 to 90 psi. may be used to actuate the cylinder. Four machines of the type described have been installed and are said to have solved the problem.



INTERNATIONAL NEWS PHOTO

NEW ARMY AIR DREADNOUGHT

This 139-ton Consolidated-Vultee B-36 plane can carry an atom bomb to any inhabited area on earth and return to its base without refueling. Its maximum load capacity for short trips is 36 tons, enabling it to take along its own fighter escort planes and launch them when near the objective. The craft is pressurized for the comfort of its 12-man crew during stratospheric flight. Following tests of the initial model, the Army announced that it had ordered a "substantial quantity" of the new bombers. The lower view shows a crew member on his back pulling himself through an 85-foot-long pressurized magnesium-walled tunnel that connects the fore and aft compartments.

Sound Waves Inspect Metal

DURING the war, German technicians developed a supersonic method of locating bubbles in sheet metal too minute for detection by X-ray or magnetic processes. A report on the device prepared by Dr. G. J. Thiessen, a member of the National Research Council at Ottawa, Canada, states that the method tests sheet metal for imperfections by comparing the energy of supersonic vibrations before and after passage through the metal. Anything greater than the normal drop in transmission indicates the presence of a flaw. Experiments have shown that a bubble only one-hundred thousandth of a millimeter in diameter can cause a hundredfold drop in energy. Slag- or rust-filled bubbles do not cause a drop of like magnitude but, even so, are readily discovered.

The supersonic vibrations are generated by a 15-watt quartz-crystal sender that operates at 1000 kilocycles and "wobbles" the frequency 100 cycles per second to prevent standing waves in the metal undergoing test as well as between the sender and receiver. The vibrations are transmitted by a metal block to a narrow chamber of running water which, in turn, passes them on by making contact with one edge of the test metal. A similar arrangement picks up the vibrations at the other edge and forwards them to the receiver. The sending and receiving units are attached to opposite ends of a long pair of tongs that straddle the sheet, move along its edges, and are kept in contact therewith by hand pressure or by springs in the tong handles.

Full details about this and other methods of inspecting metals are contained in a report, entitled *The Non-Destructive Testing of Materials and X-Ray Protection Methods*, which can be obtained in photostat, microfilm ($1), or mimeographed form (25 cents) from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

COMPRESSED AIR HANDBOOK

New Books

Reference Volume on Pneumatic Equipment and Practices for Both the Operating Man and the Layman

DESPITE the extensive and varied uses of compressed air, relatively little literature has been available to assist engineers and others in the installation and operation of air compressors and air-powered tools and equipment. The need for such assistance is great, and to meet it partially Compressed Air and Gas Institute has published *Compressed Air Handbook*.

The volume is designed to serve as a source of reference data for technical and engineering purposes and to inform both the student and the layman of the adaptability, flexibility, and usefulness of compressed-air power. In addition to considerable data of recent origin that has not been available previously in a single book, it contains in revised and improved form all the reference material formerly published as *Trade Standards*.

Nineteen of the nation's leading manufacturers of compressors, air-operated tools, and allied equipment constitute the membership of the Compressed Air and Gas Institute, and they have pooled their experiences and knowledge in the new handbook, which has been in course of preparation for two years. An idea of its contents may be gained from the following chapter headings: Typical Applications of Compressed Air, Representative Types of Compressor Installations, Portable Air-Operated Tools and Rock Drills, Engineering the Compressor Installation for Maximum Efficiency, and Compressed Air Engineering Data and Test Procedure.

Compressed Air Handbook contains four hundred 6x9-inch pages, with 247 illustrations, including photographic reproductions and diagrams. It is bound in stiff-backed simulated leather, with gold-embossed lettering. Available from Compressed Air and Gas Institute, 90 West Street, New York 4, N.Y. Price $3 in the United States; $3.50 elsewhere.

ILLUSTRATIONS FROM "COMPRESSED AIR HANDBOOK"

The actual pressure available at a pneumatic tool can be learned, as shown above. A hypodermic needle, to which a gauge is attached, is inserted into the air hose close to the tool and the reading taken. When the needle is withdrawn, the hole seals itself.

The controlled breathing apparatus shown above in the hands of a nurse has saved many lives in hospitals. Intermittent pulsations of compressed air simulate the natural action of breathing when a patient needs this assistance while on the operating table.

Meat loaves baked in a packing house were formerly removed from their pans by pounding the latter on a table. This took time and labor and was hard on the pans. A jet of compressed air applied around the edges of a loaf now quickly loosens and ejects it.

A Mining Romance

JOSEPH R. LINNEY spent the early part of his adult life in the anthracite coal-mining district around Scranton, Pa., and rose to an executive position with one of the large operating companies. More than a quarter-century ago the same concern assigned him to direct the nation's largest magnetite iron mines in the Adirondack Mountains of northern New York. These properties, some located near Port Henry and others near Plattsburg, have been worked since 1938 by the Republic Steel Corporation. Mr. Linney served as general manager of the mines until a year or two ago. His two sons Robert and William, well known in the sports world as makers and breakers of bobsledding records, are now in charge of them.

These biographical notes are set down here because there is much similarity between the career of Joe Linney and that of Jim Lane, the hero of a novel with which Mr. Linney has busied himself since retiring from mining. In his introduction the author states that the story is a combination of fiction and fact, but admits that the inspiration for writing it came out of his own experience in the mining field. In any event, the novel opens with Lane, a young mining engineer, being transferred from the Pennsylvania anthracite mines to the New York iron mines, and then traces his steps in rehabilitating the run-down properties and instituting new milling methods to produce a concentrate of the required iron content for commercial steel-plant utilization. He succeeds with the aid of Betty Dale, a community nurse, and their romance forms one of the main threads of the tale.

Tales of the Rideau Lakes

AUTHOR, FISH, AND LOCK

British soldiers, working under the Royal Engineers, spent five years and $5,000,000 building 47 locks and 24 dams and digging 6 miles of canals to enlarge the Rideau Lakes and to connect them into a 126-mile navigable waterway. Little Rideau Lake is the high point, from which there is a 277-foot descent to Ottawa and one of 161 feet to Kingston. One dam, at Jones' Falls, is 400 feet long, 80 feet high, and 300 feet thick at the base. The masonry in the dams and lock walls consists of accurately cut limestone blocks, laid without the aid of machinery in tiers, that are in as good condition today as when they were put there. The original massive lock gates were of oak. Now they are of Douglas fir, and they are renewed on an average every ten years. All locks are 124 feet long, 24 feet wide, and 6 to 8 feet deep. One of them is shown at the right filling with water. At the top Clint Fleming is contemplating a large-mouth bass.

A MAN who has devoted 45 years to guiding fishermen knows a lot about both fishing and human nature. That is probably the reason why a new book, *When the Fish Are Rising*, makes good reading. Its author, Clint Fleming, has spent almost half a century with fish and people, and the fourteen stories that make up his maiden effort at writing cover many types of both. Consequently, you don't have to be a fisherman to enjoy it.

Fleming does his guiding in the Rideau Lakes district of Canada, and his introductory chapter on its historical background will interest construction men and engineers. The lakes were canalized by order of the Duke of Wellington following the War of 1812. Fearing further trouble between Canada and the United States, he built a waterway from Ottawa to Kingston over which troops and supplies could be moved as an alternate route to the Yankee-fortified St. Lawrence River. The canal, of whose 126-mile length only 6 miles had to be dug, never had to be used for military purposes, but it did provide one of the finest fishing grounds in North America. It is now largely patronized by vacationists from the United States.

Through the pages of the book pass expert anglers with their expensive outfits, native Canucks who catch their share of fish with heavy poles cut in the bush, and tired businessmen who often find the tonic of the outdoors better for their real or imaginary ills than medicine. The finny characters include pike, walleye, muskellunge, lake trout, and especially large- and small-mouth bass. From a lifetime of experience, the author writes of their habits, peculiarities, obstinacies, and of the best lures and techniques for taking them.

Woven into the stories are word pictures of the natural beauty of the Rideaus, the author's fishing tips, theories on conservation, and philosophy of life. The duties of a guide are also set forth. In his day, Fleming estimates, he has prepared 5000 shore dinners, and he touches pleasantly on that subject. His secret of why these meals taste so good is explained in his reply to a lady who had just helped herself to a second serving of bass despite the fact that "she just couldn't eat fish at home." To her he said:

"Oh, I just stir in a few laughs, add a little smell of white cedar and a touch of wood smoke, and some of our good Canadian fresh air. It makes quite a dish." That's the way with Clint's book. As reading fare, it makes quite a dish.

Published by Duell, Sloan and Pierce, Inc., 270 Madison Avenue, New York, N. Y., and obtainable from our Book Department. Price $3.50.

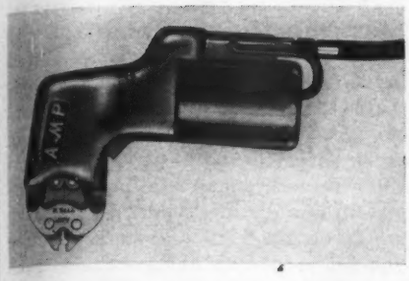
New Process Forecasts Wider Use of Titanium

PILOT-PLANT operations at Boulder City, Nev., by the U. S. Bureau of Mines may lead to a wider use of titanium, which is described as a light metal of exceptional chemical and physical properties. Ductile in the pure state so that it can be fabricated and worked, it is said to be superior to aluminum and magnesium on the basis of strength and weight and to possess many of the valuable properties of stainless steel. However, it has been difficult to produce in the pure state, and that has limited its industrial application.

By the new process developed by the Bureau of Mines, pure titanium chloride is dripped onto molten magnesium in the presence of helium under slight pressure. The mixture thus obtained is wet-ground, screened, and leached with dilute hydrochloric acid, yielding a powder that is pressed into briquettes and sintered at 1830°F. under a high vacuum to remove the hydrogen picked up during leaching. The sintered material, it is claimed, can be rolled at room temperature with reductions of 20 percent before annealing, or of as much as 75 percent at 1200°F. Output of the pilot plant is about 100 pounds of pure titanium a week.

Though cost of production by the improved method is still relatively high, the expectations are that large-scale operations will effect some economies. Be that as it may, the simplified reduction furnace promises to make pure titanium available for uses where its favorable properties outweigh price and for the manufacture of airplane parts; diaphragms that are maintained under tension; spindles, spools, and other working components of textile machinery; certain types of springs; and other products where lightness, strength, and resistance to corrosion are vital factors.

Industrial Notes



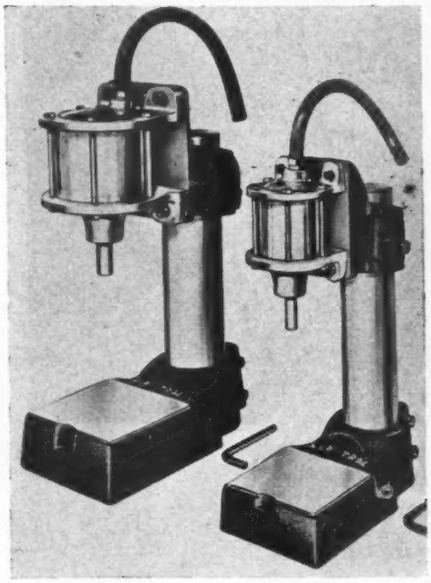
Designed for production-line assembly, a pneumatic hand tool for crimping solderless electrical terminals onto wires has been announced by Aircraft Marine Products. Built for wire sizes from 22 to 14, the unit makes complete connections as fast as operator can insert the wire and pull the trigger. The toggle action employed provides 2000 pounds crimping pressure with air at 85 pounds psi. and low consumption. Hardened tool-steel crimping jaws are readily interchangeable for the various types of solderless terminals manufactured by the company and accommodate a number of sizes. Tool is said to be small enough for service in hard-to-reach spots and light enough to prevent operator fatigue when used continuously.

Detection of faulty bearings in engines of automotive vehicles is the purpose of a portable device developed by the Federal-Mogul Corporation. It does its work without the necessity of tearing down the engine, it is claimed; only involves dropping the oil pan and hooking up the equipment to determine the condition of all main, connecting-rod, and camshaft bearings, as well as of the oil lines in any full-pressure lubricating system. Detector supplies clean oil at constant pressure and indicates leaky, tight, or defective bearings or plugged lines by the volume of the escaping oil.

Rubber-bonded abrasives in stick form are being made by the Sandusky Abrasive Wheel Company for a wide variety of metal-finishing operations. The material can be cut with a jacknife, file, grinding wheel, hack or band saw and enables tool and die men, pattern-makers, etc., to provide themselves with special shapes for cleaning, deburring, and polishing threads, grooves, corners, curves, and other contours. Sticks are available in fine, medium, and coarse grains; in 3-, 6-, and 8-inch lengths; and in four standard shapes—rectangular, square, triangular, and round.

Made in two sizes for light and heavy duty, the improved Kant-Mar hammer announced by Schmidgall Products is said to be tough enough to take punishment and yet soft enough so as not to damage delicate surfaces. Either size is available in a plain model or with replaceable tips of Velv-Alum, a precision-turned special aluminum alloy that does not chip. Handle of selected-grade hickory fits into oval hole in head to insure tight hold.

Two new air arbor presses that combine the features of arbor and kick-type machines have been designed by Air-Trol to supplement its line of fast-action, spring-return pneumatic cylinders for material-holding operations. One is a heavy-duty model weighing 72 pounds, and the other a 40-pound unit delivering, respectively, around ¾ and ¼ ton at 150 pounds line pressure. Presses are set for a given application by regulating the air pressure, thus always insuring just enough to do uniform work and to obviate the danger of crushing incident



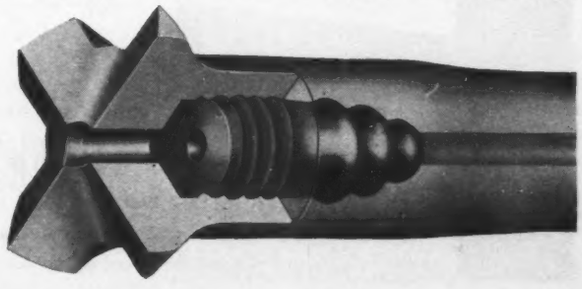
to manual operation. When controlled by foot valve to leave hands free, machines deliver full stroke with less than 1 inch movement of pedal. Cylinder brackets are adjustable on the column to provide a ram clearance ranging from 0 to 6 inches.

Ingersoll-Rand Company has recently added a 4-point detachable bit of the stud type, designated as the Stud Jackbit, to its line of rock-drilling equipment. The new design, shown at the right, permits making the bit, stud, and drill rod of materials best suited for the functions peculiar to each and to place more material especially at points in the bit where it is most needed. The result is a tool of increased strength which, in combination with carefully worked out wing curves that allow gauge reductions of 1/16 inch and less, makes it possible to drill faster than normally, as well as to start holes with smaller bits and still bottom them the same size as before. The bit is said to retain its proportions with successive resharpenings and to perform like a new one throughout its lifetime.

The Jackstud is factory-made of high-grade carburized alloy steel. One end is deeply furrowed and cone-shaped and is driven cold into the heated rod. This work can be done on an I-R sharpener with the aid of a set of special accessories. The bit end has case-hardened reverse buttress threads that keep their shape and extend right up to the driving shoulder—there is no undercut into which the bit skirt can upset and become locked. Bit is therefore easily detached from the rod. Further information is contained in a bulletin—Form 4062—obtainable from Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., or any of its branch offices.

An inorganic membrane for use with waterproofing compounds has been introduced by the Lexington Supply Company. The fabric is made of Owens-Corning Fiberglas and is of open-mesh weave to permit full impregnation by coal tar or by asphalt bitumens. So treated it adheres firmly to rough and irregular surfaces, molding itself to the contours, and is suitable for the protection of roofs, brick and concrete walls above or below ground, and for many other purposes in the construction industry. Called Glasfab, the yarn does not rot and does not char or burn when a hot compound is applied. Neither do the fibers carry moisture into the waterproofing by capillary action nor permit the escape of volatile oils essential to its durability. Because of these inherent qualities of glass, the membrane is said to give the impregnating materials much longer life than they have normally.

Experimental work conducted in the chemistry laboratories of the University of Michigan have resulted in a machine that makes use of a stream of electrons to study the atomic structure of metals and gases and to identify invisible films of foreign materials on metal surfaces. The unit is based on a model developed



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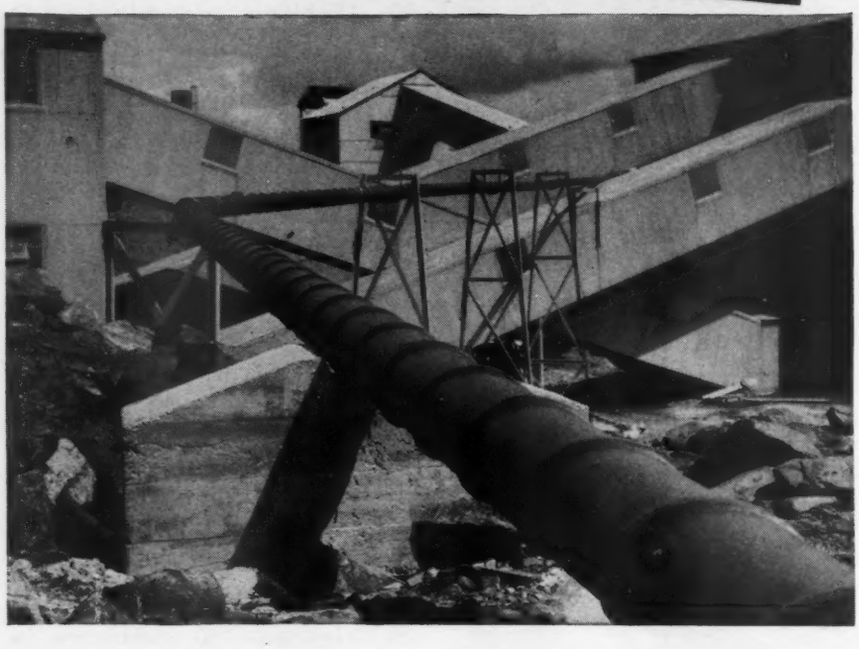

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by Prof. Lawrence O. Brockway and consists basically of a vacuum chamber with a holder for a specimen in the center and another for a photographic plate at the opposite end of the source of electrons. The metal to be examined interrupts the flow of 40,000-volt electrons produced by the machine, causing them to be deflected and to expose the negative. Because each metal breaks up the stream in a distinct pattern, the photographs obtained differ, and it is therefore possible to identify unknown substances by comparing the diffraction patterns with those of substances previously identified. This new method of analyzing metal surfaces is said to have numerous fields of practical application, including painting, lubrication, electroplating, and welding.

Officials of the Refractories Division of The Babcock & Wilcox Company have announced the development of a concrete, designated as B & W Kaocast, that readily withstands temperatures as high as 3000°F. The material may be poured like ordinary concrete or applied by ramming, and may be used for the fabrication of special shapes or to form part or all of the furnace lining. In laboratory and protracted service tests the material is said to have shown excellent stability and resistance to disintegration under repeated heating and cooling cycles, small volume change on initial firing, and negligible shrinkage and expansion under continuous service at high temperatures. Among other applications listed for the refractory are: as a covering for studs in water-cooled furnace walls, for making high-temperature baffles, and for deep-patching of spalled or eroded brickwork.

ERASER OF GLASS

The ends of myriads of hair-thin glass fibers encased in a plastic holder form the rubbing surface of a new typewriter eraser produced by The Eraser Company, Syracuse, N. Y., under the name of Rush-Fybrglass. The fiber sheaf is moved in or out like the lead in a mechanical pencil and can be replaced by a refill when depleted. The maker claims it works with such light pressure that no shield is needed to protect carbon copies from smudging.

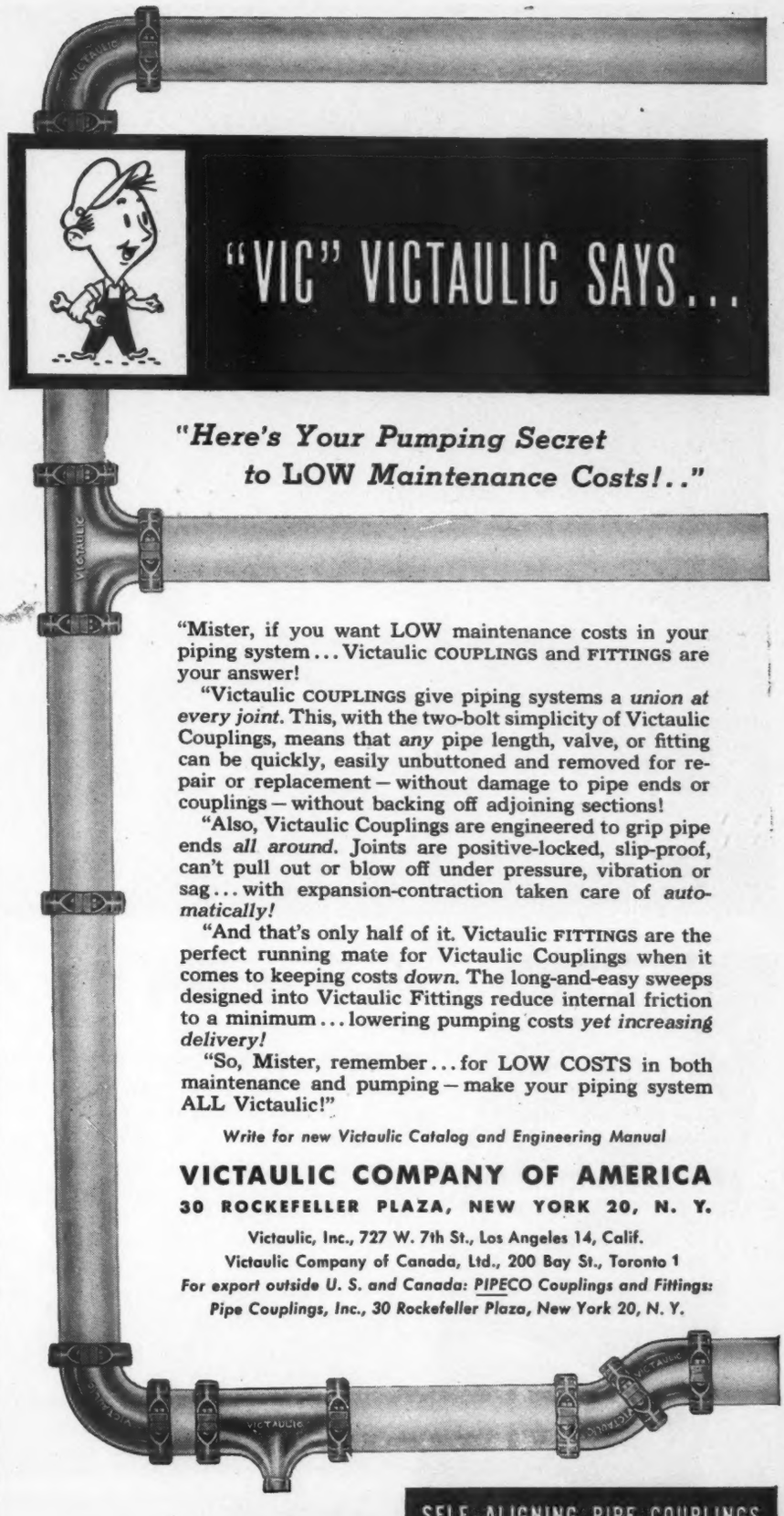
TUBELESS TIRE

Cross section of a tubeless pneumatic tire now being tested by The B. F. Goodrich Company, Akron, Ohio. The puncture sealant permits it to be driven over upturned spikes without loss of air. A taxicab fleet in one city, Ohio State police cars, and some privately owned cars are using the tires experimentally and they are now being offered for limited sale. The tire is believed to have attained a goal sought by manufacturers since the advent of the automobile era.

For deep-sea diving operations, Westinghouse Electric Corporation has produced a 1000-watt incandescent light that is about the size of the average household lamp. It is not suitable for ordinary use, however, because its filament, which almost touches the bulb, would cause the light to burn out instantly unless surrounded by water to keep it cool.

To discover the oldest installations of 85 percent Magnesia insulation still serving effectively, The Magnesia Insulation Manufacturers Association has announced a contest with sixteen prizes as awards. The first is a $100 Savings Bond, and there are five second and ten third awards. Each second-prize winner will receive a Telechron electric cyclometer-type clock, and each third an electric desk clock. Entry blanks may be obtained from the association, 1317 F Street, N. W., Washington 4, D.C. Contest closes on October 10.

Draw-Kleen, if it does all that is claimed for it, should prove a boon to draftsmen, especially in humid weather. The material is in the form of soft, dry crumbles and is dispensed from a shaker-top can. It is sprinkled on paper or tracing cloth before drawing is started and brushed off after rubbing when completed, leaving surfaces free from perspiration, dirt, and pencil smudges. Draw-Kleen is a product of Craftint Manufacturing Company, Cleveland 10, Ohio, and is also suitable for cleaning blueprints, artwork, maps, documents, etc.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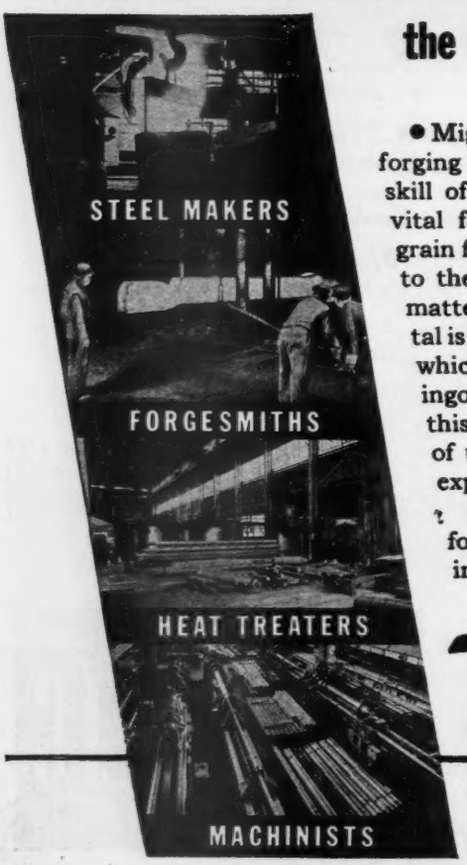

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